ANNUAL REPORT

1954

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RUBBER RESEARCH INSTITUTE OF MALAYA

COMMONWEALTH MYCOLOGICAL INSTITUTE
12 JAN 1959

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Price three dollars

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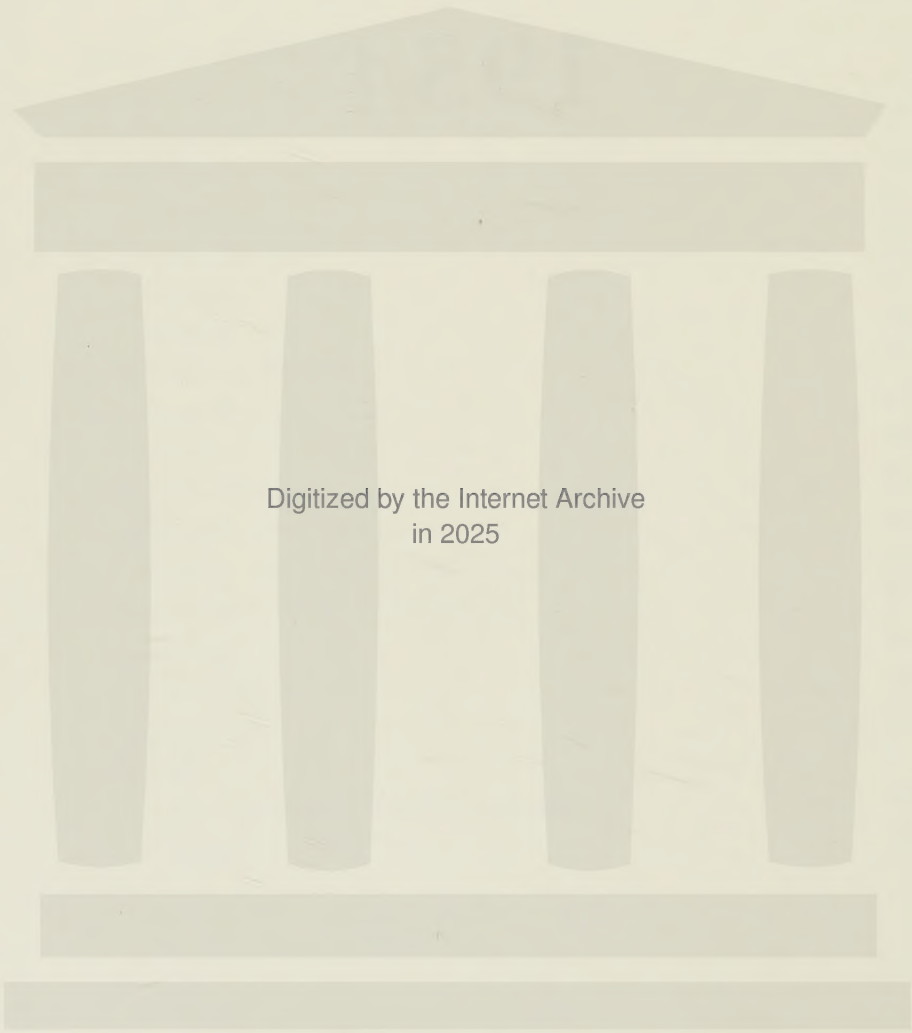

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Report of the Board

The constitution of the Board is as prescribed by Enactment No. 14 of 1934 and the personnel at 31 December 1954 was:

a The Director of the Institute — ex *officio* — Chairman

b The Secretary to the Treasury, Federation of Malaya — (Financial Member appointed by the High Commissioner)

c The Director of Agriculture, Federation of Malaya — ex *officio*

d Members appointed by the High Commissioner to represent the interests of smallholders

The Hon'ble Tuan Haji Sheikh Ahmad bin Sheikh Mustapha, C.B.E., J.P., M.C.H.
Mr Fong Yeok Seng

e Members appointed by the High Commissioner from a panel of 12 persons nominated jointly by the Rubber Growers' Association, the United Planting Association of Malaya and the Malayan Estate Owners' Association:

Mr K. Arumugam
The Hon'ble Mr G. M. Knocker
The Hon'ble Mr J. C. Mathison, O.B.E.
Mr R. A. Coles (Mr L. Rogers, acting)
Mr D. W. Hawkins

The members under (*d*) were appointed by the High Commissioner for a period of three years from 1 September 1952. Mr Knocker and Mr Arumugam were appointed on 1 September 1953, Mr Mathison and Mr R. A. Coles were appointed from 1 November 1953, and Mr Hawkins from 1 December 1953 all for three years.

At close of the year the other members of the Board were:

(*a*) Mr C. E. T. Mann (*b*) Mr C. R. Forsyth, M.C.S. (*c*) The Acting Director of Agriculture.

The Permanent Committee consists of five members of the Board:

The Director of the Institute — ex *officio* — Chairman
The Financial Member — ex *officio*
Three members appointed by the High Commissioner.

At 31 December 1954 the three appointed members were:

The Hon'ble Tuan Haji Sheikh Ahmad
The Hon'ble Mr G. M. Knocker
One vacancy caused by the retirement from Malaya of Mr O. J. Voelcker.

During the year the Board held three statutory meetings, the Permanent Committee met five times.

Detailed plans and estimates for the year 1954, and proposals for further development of the work of the three principal research and development bodies were submitted to the Controller of Rubber and the Malayan Rubber Fund Advisory Committee and were referred to the constituent Associations.

The estimated cost of the draft programmes submitted in 1953 exceeded the estimated revenue based on the income to be derived from the Schedule III cess of half a cent a pound on exports; revision of programmes was called for. The Board submitted revised plans which, together with those of the British Rubber Producers' Research Association and the British Rubber Development Board, were referred for coordination in the United Kingdom at the request of the Rubber Growers' Association in London. Agreement on a coordinated budget for all research development and advisory services financed by the Malayan Rubber Fund for the year 1954 was reached early in June 1954.

Meantime, the Board decided that it would not be prudent to fill vacancies on the senior staff of the R.R.I. during the first half of 1954. It was also decided not to embark on any new lines of research during the same period, nor to incur expenditure other than that required for essential work the value of which might be seriously impaired if continuity were to be broken. Consequently, the year 1954 was regarded as a holding year by the Board; the period has been one of consolidation on principal research projects whilst maintaining advisory and information services at normal level.

Much of the time of the Board and of the senior staff of the Institute has been spent in the further consideration of plans for the period 1955-1959. Draft plans were submitted to the Controller of Rubber and the Malayan Rubber Fund Advisory Committee at the end of the year, and are now being considered by the representative Associations of the Industry.

Estimated total expenditure of the Rubber Research Institute for the year 1954 was $3,650,000 of which $2,900,000 represented expenditure on all services provided from Headquarters in Kuala Lumpur and $750,000 covered expenditure on the R.R.I. Experiment Station at Sungei Buloh. Estimated revenue on the Experiment Station for the year is $733,000 derived from sales of rubber and planting material.

C. E. T. Mann
Chairman of the Board

Report of the Director

There have been no radical changes in the organisation of the work of the Institute on a Divisional basis. Work falls naturally into two broad sections namely, work on production and work on the product. Work on production is undertaken by the Botanical, Soils and Pathological Divisions, work on the product is the province of the Chemical Division.

The Smallholders' Advisory Service, working in cooperation with State Agricultural Officers, the Rubber Industry (Replanting) Board — Fund B, the Rural and Industrial Development Authority, and the Cooperative Societies Department, has continued to serve smallholders.

The Statistical Section and Information and Publications section render assistance to all Divisions.

The R.R.I. Experiment Station provides for a large part of the field research programme and, through the factory and new laboratories, provides facilities for the expansion of fundamental research on latex, and the development of new products and processes in the preparation of natural rubber for the consumer.

Notes on the work of the Divisions follow.

BOTANICAL DIVISION

Research—A series of new families of legitimate seedlings were obtained from 6500 hand pollinations, representing twelve different crosses, made during the short main flowering season of 1954. Approximately five hundred new clones were made from the legitimate seedlings of the 1952 hand pollination programme and were budded in a field trial.

A trial of 216 clones made from seedlings of an R.R.I. seed importation from Tropical America was establised during the year, this collection includes new strains of *Hevea brasiliensis* from different regions of the Amazon valley.

Budwood of eight Dothidella-resistant clones was received during the year from the Plant Introduction Garden of the U.S. Department of Agriculture in Miami, Florida, completing the establishment in Malaya of the twentyfive clones exchanged with the Instituto Agronomico do Norte, Brazil for the same number of R.R.I. clones. An international exchange of twenty of the most promising new clones developed by the Rubber Research Institutes in Ceylon, Indonesia (Java and Sumatra), Indochina and Malaya, approved by the Board on the recommendation of the Directors' Liaison Committee at a meeting held in March at Bogor, was carried out during the year, and as a result eighty new clones, representing the best of recent selections in other countries, have been established on the R.R.I. Experiment Station.

Experiments on full circumference tapping systems and on tapping systems for use on material susceptible to brown bast, especially clonal seedlings, were continued during the year. A series of slaughter tapping experiments has been concluded; they have shown that tapping systems with multiple superimposed cuts tapped at 150 per cent and 200 per cent intensity and combined with the use of a yield stimulant give high yields with a considerable saving in tapping costs.

High tapping commencing at 90 inches above the union in the virgin bark of budded trees which yielded little on second renewal bark has resulted in greatly increased yields, the mean increase on the half spiral alternate daily system over a period of five months

being 75 per cent. Trees tapped on both high and low half spiral cuts alternate daily gave a yield increase of 159 per cent, the yield of the low cuts being only very slightly affected by tapping of the high cut on the opposite panel.

Experiments on yield stimulation have shown a gradually decreasing response to successive six monthly applications of a yield stimulant but no increase in the incidence of dry trees after six successive half yearly treatments. The properties of the latex concentrate and of dry rubber have not been affected by the use of the yield stimulant. The use of yield stimulants has also resulted in a significant increase in the thickness of renewed bark.

A method of tree destruction using a 5% acid equivalent solution of the normal butyl ester of 2,4,5-T in diesel oil was perfected and has been adopted by the Rubber Industry (Replanting) Board for use on smallholdings.

Yield recording in the R.R.I. experimental plantings on estates continued throughout the year.

During 1954 eighty acres on six estates have been devoted to the testing of R.R.I.M. 600 series clones, making a total of about 600 acres of post-war experimental plantings of R.R.I.M. 500 and 600 series clones.

Nine hundred and fortysix advisory letters were despatched during the year. Research Officers paid advisory visits to 28 estates and the number of visitors to the Division totalled 114. Fifteen lectures were given to Planters' Societies.

Advisory leaflets on the use of 2,4,5-T for yield stimulation and for tree destruction were prepared and distributed to estates. Four major articles and two brief articles prepared by members of the Botanical Division were published in the *Planters' Bulletin*.

SOILS DIVISION

Research manuring—Results of experiments on phosphate manuring in replanted areas showed that mixing of the phosphate (soluble or insoluble) with the top six inches of soil in the planting hole was more effective than surface application or band placement below the surface. Furthermore, the results do not support the suggestion, commonly expressed, that soluble superphosphate is either quicker acting or more effective than insoluble rock phosphate for manuring of young rubber. Rock phosphate was equally effective whether used as a fine powder or as coarser material. There was a suggestion that granular superphosphate applied in the planting hole was more effective than the fine grained fraction.

Application of magnesium (2 oz Kieserite) in the planting hole, and again 4 months later, produced a highly significant depressive effect on growth of the young plants. In another experiment designed to study the effect of phosphorus and magnesium on older, but still immature, PB 86 trees showing symptoms of magnesium deficiency, there were indications of a temporary beneficial effect on growth due to magnesium in the absence of phosphate. Mature trees showing symptoms of magnesium deficiency responded to treatment with magnesium lime. Chlorosis of the leaves was noticeably less in the third year after the first application. Tentative conclusions which may be drawn from the results of manuring experiments in young mature areas are:

i Manuring in the early years after commencement of tapping may improve rate of growth and increase production during the first tapping cycle in several areas, although the magnitude of the effect at this stage is not large. The effect of this early manuring on yields later, when renewed bark is tapped, remains to be determined.

ii When there is a response to manuring during early tapping years, either in terms of growth or yield, this is attributable mainly to nitrogen and to a lesser extent to phosphate. The effect on yield becomes apparent some 5 to 6 years after commencement of the manuring programme. No improvement due to application of potash has been detected in the experiments under review, except that between 2 and 4 years after the first application there is an indication that the small beneficial effect due to nitrogen, which is developing, occurs only in the presence of potash. Later on, the response to nitrogen is less dependent on the presence of potash.

Cultivation and ground covers—Sodium trichloracetate (S.T.C.A.) applied at the rate of 100 lb per acre will kill most weeds including lalang. An assessment was made of the damage that can be caused to young immature rubber trees by this treatment. Applications at the rate of 50 lb per acre caused severe defoliation of 15 per cent of the trees, and the damage increased progressively with increasing rates of application. Most of the trees recovered later but mortalities can be expected if the rate of application exceeds 100 lb per acre.

Investigations were carried out to determine the effects of various formulations of the hormone type weedkillers on a mixed population of indigenous cover plants. The butyl ester of 2,4,5-T and the mixed esters of 2,4,5-T and 2,4-D were the most effective, killing several of the indigenous plant species, but not grasses and some ferns. The control of light grasses and ferns by spraying has been investigated further. Encouraging results have been obtained with a new herbicide called Dalapon.

Experiments designed to assess the effects of mulching in young rubber areas are in progress. Preliminary results show a small beneficial effect (about 6 per cent) on growth of 2 years old buddings in the first six months after placing a mulch around the base of the plants.

Plant investigations—Fundamental studies on the nutrition of the rubber plant have been carried out. Detailed observations on the visual symptoms of deficiency of nutrient elements have been recorded. Deficiencies of each element studied, except calcium, resulted in the development of fairly well defined abnormalities which, having been recognised, will be useful for diagnostic purposes in the field.

Rubber plants survive and grow satisfactorily when ammonium compounds only are supplied as a source of nitrogen, although application of nitrogen in the form of nitrate produced a greater response in dry weight. There is a suggestion that the response, in terms of the total dry weight per plant, to nitrate nitrogen may be dependent upon the calcium concentration of the nutrient medium.

Interclonal and seasonal variation in the composition of rubber leaves were studied. The concentration of rubber in the leaf stalks and the concentrations of chlorophyll, nitrogen, phosphorus, potassium, calcium and iron in the leaf blades varied according to clone and also varied markedly from month to month. The concentration of rubber and the concentrations of chlorophyll, calcium iron and manganese increased, while the concentrations of nitrogen, phosphorus and potassium decreased with increasing age of leaf. Seasonal variation in rubber, nitrogen and iron concentrations was associated with rainfall. A study of the composition of plants grown under controlled conditions showed interrelationship between various nutrient elements. There is a close interrelationship between magnesium, potassium and phosphate, also between magnesium and manganese.

There is a suggestion that the incidence of fungal leaf disease may be related to the mineral status of the plant. The incidence of infection by *Helminthosporium heveae* appeared to increase with either ammonium or nitrate level, but these are preliminary observations and require confirmation by further study.

Advisory work—Manuring and weed eradication continued to be the main subjects of enquiry. Early in the year interest was aroused in the suggestion that leguminous creepers may respond to treatment with molybdenum. Small scale trials carried out at the Experiment Station showed no detectable beneficial effects. Judging from number of enquiries, interest in the subject waned towards the end of the year which probably indicates that results of trials on estates were equally disappointing. Methods and degree of control of ground cover is another subject which seems to be receiving more attention judging from correspondence.

The majority of visits to estates were made in response to requests to investigate the causes of backward growth or abnormal defoliation in young rubber areas, and to advise on manuring in both mature and immature areas.

Articles on weed control in young plantings and establishment of leguminous covers were prepared for *Planters' Bulletin*.

PATHOLOGICAL DIVISION

Research—The effect of stump poisoning in one replanting experiment has been to cut root disease incidence in the young stand by two thirds as compared with control plots where stumps were left untreated. The actual method of poisoning used has had little influence on the result so far. Early results in another experiment show tree poisoning to be more effective than stump poisoning. A new area has been made available for field observations on root disease in relation to replanting.

Experimental inoculations of young seedlings with white root disease have given reactions that are not yet understood. A fundamental study of the fungus and a study of other micro-organisms associated with the major root disease fungi has been initiated.

The susceptibility of legume covers to the three major root diseases of rubber has been studied. All can be infected by at least one; most by all three.

New fungicides have been tested against mouldy rot and the observation made that the intensity of infection decreases sharply with reduced frequency of tapping.

A suspected relationship between the nutrition of young plants and susceptibility to leaf disease was confirmed for one disease on plants growing under controlled conditions.

Field experiments have been conducted on the control of pink disease and black stripe.

Inter-territorial exchanges of planting material, which have increased in volume in recent years, have required careful attention to plant sanitation measures. It has been shown that budwood is not injured by a surface sterilisation procedure that is a valuable aid in excluding pathogens.

The latest chlorinated hydrocarbon insecticides under test against termites are found to persist well in soil and to give excellent results.

Tests have been carried out to find the relative susceptibility of legume covers to eelworm attack, in anticipation of problems arising in plantations.

Insects that may pollinate hevea have been collected.

Advisory work—There has been no decline in the volume of advisory correspondence although the subject is steadily being covered by articles in *Planters' Bulletin*. The root diseases have been fully dealt with, being most serious, the problem approaching the insoluble in some replantings where the land was cleared by felling without poisoning the stumps, and where control measures were neglected.

The need for taking steps to control pink disease in immature rubber, particularly in the wetter parts of the country, has become more apparent. Fungicides are effective but applying them is difficult and slow.

Secondary leaf fall was not generally severe. Its incidence and causation were followed by examining specimens sent in from all over the country.

The demand for root nodule bacteria to inoculate legume cover crop seed has risen steeply, necessitating much routine work in testing, multiplying and distributing cultures. Methods of pretreatment of seed were studied for inclusion in a general article on the subject.

Research Officers gave four lectures to Planting Associations.

CHEMICAL DIVISION

The work of the Chemical Division has as its objectives four main targets, namely to:

a maintain advisory services to producers,

b produce rubber more cheaply and of better quality and presentation;

c improve the quality of latex concentrate particularly for the foam rubber market;

d produce special and modified rubbers to fulfil specific consuming needs in competition with synthetic products.

In attempting to achieve these targets a direct approach is not always possible, because the basic information necessary to success is often not available. The first step in many instances is therefore a fundamental research project, directed to establish the facts required. The next stage consists of applying the knowledge available to the objective in view and developing satisfactory practical processes; this is applied research and continues into technical development as the objective begins to take shape on a large scale. The final application to commercial scale operation brings the achievement of the target and the whole process then passes on to add one more advisory service to producers.

Research—During 1954, research investigations were largely concerned with the non-rubber constituents of latex, the mechanism of latex coagulation, and studies of the rubber hydrocarbon. Bacterial and enzyme surveys of latex have also been continued.

In the field of applied research and technical development promising new products have been studied, including latices with new systems of preservation, masterbatches of rubber and lignin, purified crepe, sheet and crepe with superior processing properties, and graft polymers, which comprise natural rubber into which synthetic molecules have been grafted. Many of these materials are now undergoing trial by manufacturers in the United Kingdom.

In cooperation with the R.R.I. cyclised rubber production has been established in Malaya on a commercial basis by a member of staff of Rubber Technical Developments Ltd., seconded to the R.R.I. from the United Kingdom for this work. Five commercial companies were in a position to undertake preparation by the end of the year.

Advisory work—Advisory work in the Chemical Division has covered the usual wide field of enquiries, outstanding among them being questions concerned with latex concentrate and with the manufacture of pale crepe. Much useful work in improving the quality of latex concentrate has been carried out on the basis of the VFA (volatile fatty acid) test, which has been developed by the Division during the past few years.

The bleaching of crepe using the R.R.I. process with 'Emulsion A' concentrate still provides minor difficulties in operation, which require systematic study before satisfaction is gained. Considerable interest has also been shown in methods of preparing air-dried sheet, particularly in respect of good and even colour.

The main technical difficulties associated with the preparation of T.C. Rubber in Malaya have been overcome and producers are urged to extend classification to include a larger proportion of the total production of dry rubber. During December the estimated rates of production in Long tons/annum for the various sections of the industry were as follows — estates 38,000; packing houses 4,800; remilling factories 1,300. In the latter part of the year consumer interest has stimulated production of T.C. Rubber by packing houses and remilling plants but the outturn from estates has remained unchanged, the entry of new estates being counterbalanced by the withdrawal of larger estates turning to the production of latex concentrate.

An important and significant development is the view of marketing organisations that Technical Classification facilitates the sale of natural rubber. The use of T.C. rubber is restricted however, by the limited supplies at present available to manufacturers. Coordination of all technical work on the preparation and testing of T.C. rubber in the Far East is now carried out by the Institute on behalf of the International Rubber Research Board.

SMALLHOLDERS ADVISORY SERVICE

At the end of the year the field staff comprised 31 Rubber Instructors, 12 Junior Rubber Instructors and 24 Rubber Demonstrators; 11 Rubber Instructors resigned in January to take up appointments with the Rubber Industry (Replanting) Board. Junior Rubber Instructors are men without agricultural diplomas, they receive their early training at the R.R.I. Experiment Station.

The Smallholders' Advisory Officer was on long leave during four months at the end of the year. One Assistant Smallholders' Advisory Officer was seconded for five months to assist a Joint Working Party collecting data for the Rubber Enquiry Mission. Most Rubber Instructors undertook survey work in this connection during January and February, and later detailed studies on the costs of replanting on smallholdings were carried out.

Replanting and new planting—The implementation of smallholders' replanting schemes by the Rubber Industry (Replanting) Board greatly increased the acreage of replanting undertaken on smallholdings and much of the Rubber Instructors' time was spent in advising smallholders engaged in replanting; nearly 15,000 acres being visited during the year.

The acreage of new planting recorded was 3,360, only half that done in 1953, due partly to no new planting being undertaken in Selangor, Malacca, or Penang and Province Wellesley. Of previous plantings, 6,425 acres were budgrafted and 71 per cent of the 1954 plantings were established with clonal seedling material, the greater use of this material being on replantings.

During the short seed season 2,784,456 clonal seed were collected for the preparation of clonal seedling stumps for smallholders. From 1 July, by arrangement with the R.I.(R).B., the Department of Agriculture became entirely responsible for this work; Rubber Instructors supervised trial seed collections from new areas. During the main seedfall 361,490 clonal seed from the R.R.I. Experiment Station were distributed direct to smallholders for the establishment of kampong nurseries to provide clonal seedling stumps for new plantings.

Eight replanting demonstration plots were maintained throughout the year and 21 holdings were budgrafted with newly approved clones for demonstration purposes.

Demonstrations on the use of the normal butyl ester of 2, 4, 5-trichlorophenoxy acetic acid as a tree poison were given by all Rubber Instructors on holdings to be replanted and detailed records of the action of this chemical are being obtained.

Processing of smallholders' rubber—The sale of smallholders' latex to central sheet-making factories or for concentration continued and nearly 5,000 tons of rubber were marketed in this way, but few new collecting organisations or factories were established.

Instruction courses and demonstrations—More attention has been paid to the possibilities of extension work among groups of smallholders and courses of weekly lectures were commenced for 26 Chinese students at Batu Pahat and 38 Malay students near Muar. A one-month intensive course at the R.R.I. Experiment Station was attended by 23 young men, 17 of whom were awarded certificates on passing examinations. Rubber Instructors also lectured at courses organised jointly by R.I.D.A. and the Department of Agriculture in Perak, Selangor and Pahang.

A one month training course for 23 Replanting Subordinates was held at the R.R.I. Experiment Station, the instruction being supervised by a former Rubber Instructor who is now an Assistant State Replanting Officer.

The Rubber Research Institute vernacular films were shown at Agricultural Shows, at each of which an exhibit was prepared by Rubber Instructors. A major exhibit was prepared for the M.A.H.A. show and was also exhibited to smallholders in the Batu Pahat, Muar, Taiping, and Temerloh Districts. The mobile units of the Department of Information were used for kampong shows, but more extensive use of the films will be possible only when an R.R.I. mobile unit is obtained.

R.R.I. EXPERIMENT STATION

The Acreage Statement as at 31 December 1954 was:

	Acres
Area in tapping	1,103.50
Immature area	579.50
Nurseries	22.00
Reserve land (old reserve)	106.00
Replanting	55.75
Building site and roads	87.25
Smallholders' Nursery Reserve	202.00
New clearing	74.00
New reserve land (approximately)	726.00
	2,956.00

During the year final agreement was reached with the Forest Department on the selection, for allocation to the Board, of approximately 800 acres of reserve land in the Sungei Buloh Forest Reserve. The area now approved for alienation to the Board consists of mixed forest and lalang land suitable mainly for extension of field trials of new planting material (developed in course of breeding and selection work). It is

expected that only small portions of the area will be suitable for manuring and cultivation experiments. For this work more suitable sites on different soil types will have to be sought in other parts of the country.

New clearing—An area of 74 acres was felled, cleared and planted between June and November. The entire area is planted with seedlings for field budding for Botanical Division experiments in 1955.

Immature areas—Immature areas totalling nearly 600 acres planted from 1947 to 1953 received normal routine maintenance. They consist mainly of field-experiments established by the Botanical Division for the study of new families of clonal seedlings, new clones derived from hand pollinated seedlings, experiments in top-working of budded trees, and planting density experiments. Clone trials of new clones, other than those developed by the R.R.I., are also included.

Routine upkeep is under a general system of maintenance of between-row covers of mixed indigenous plants, leguminous creepers and bushes. Notable among leguminous shrubs is *Flemingia congesta* which thrives well on the very light sandy soil of the Experiment Station. It appears to be shade tolerant and stands up to periodic slashing over at least five years.

Planting rows have been kept clean-weeded over the first three years from planting. During 1954 encroachment of cover plants over the planting rows was encouraged and, as a measure of economy, frequency of weeding and slashing rounds has been reduced.

Pest and disease control—Routine collar inspection for the control of root disease was carried out at 6 month intervals throughout the immature areas. Special treatments were undertaken by the Pathological Division.

Manuring—No manuring was done in the immature areas except in the Soils Division experimental blocks.

Mature area—Of the total mature area, 1,114 acres were tapped throughout the year. The area includes all large scale field experiments on selection, tapping, manuring, density of planting, and comparison of different methods of upkeep under natural and leguminous covers. Recording of yields in many experimental areas involves cup coagulation on two days per month and collection of crop for drying, weighing and recording in the form of cup lump or crepe. Some 70,000 lb of rubber were harvested in the form of cup lump. From areas in which bulk yields of latex are adequate for record purposes the crop has been manufactured as latex concentrate. Details of the crop harvested in 1954 are:

	lb
R.S.S.	218,186
Latex concentrate	480,443
Cyclised rubber	21,341
Cup lump	66,368
Crepe	202,388
Vulcanised crepe	4,675
Scrap	1,000
Total	994,401

Preparation and Despatch of Planting Material—With the assistance of the Botanical Division the Experiment Station staff have taken over the work of preparation and supply of planting material, budwood and clonal seedlings and seed to estates and to smallholders (through the Rubber Industry (Replanting) Board).

The Experiment Station staff maintain the 'Smallholders' Nursery Reserve' of some 200 acres, now established as a seed garden planted on a hedge system, with intermediate nursery beds containing multiplication nurseries and nurseries for raising clonal seedling stumps.

During the year the following despatches of budwood and clonal seedlings were made:

Budwood	To Estates—	*yards*
	R.R.I. Clones of the 500 and 600 series	8,748
	Other Clones (Including exchange clones)	426
	Total	9,174
	To Smallholders—	
	R.R.I. Clones and standard proved clones	61,099
	Total	70,273
Clonal Seeds	To Estates—	
	Small consignments (for experiments only)	—
	To Smallholders—	
	To establish kampong nurseries for new planting	361,000 seeds

General—During the year the Central Electricity Board installed the grid supply of electricity on the Station to provide power for the operation of the factory and for the new research laboratory for the Chemical and Botanical Divisions.

Some 500 planters and others visited the Station during the year.

H.E. the High Commissioner and the British Adviser, Selangor, visited the Station on 10 November 1954.

C. E. T. Mann
Director

Soils Division

All three members of the senior staff were on duty for the greater part of the year. The Head of Division attended the Fifth International Congress of Soil Science in the Belgian Congo during the second half of August and was absent on home leave in September. Four Laboratory Assistants resigned and three of the vacancies were filled later. Four Field Assistants were on long leave during the year. A Graduate Research Assistant was appointed to work on problems relating to nutrition of hevea but he resigned at the end of the three months probationary period.

At the end of the year the staff of the Division consisted of 3 Senior Officers, 1 Senior Laboratory Assistant, 13 Laboratory Assistants, 8 Field Assistants, 1 Typist and 3 Laboratory Attendants.

Contributions to the *Journal of the Rubber Research Institute of Malaya* were four papers on 'Nutrition of *Hevea brasiliensis*: 1. Experimental Methods' (Communication 289), 2. 'Effect of Nutrient Deficiencies' (Communication 290), 3. 'The Interrelationships of Magnesium, Potassium and Phosphorus' (Communication 291), 4. 'Interclonal and Seasonal Variation in Composition of Leaves' (Communication 292). The first three papers were by Dr Bolle-Jones and the fourth by Dr Bolle-Jones in collaboration with Mr K. Ratnasingam.

A note written by the Physiologist on 'Effect of Mineral Status on the Concentration of Rubber in *Hevea brasiliensis*' was published in *Nature* and another short paper entitled 'The Interrelationships of Magnesium, Potassium and Phosphorus, and their Effect on the Growth and Composition of *Hevea brasiliensis*' was prepared for presentation at the Fifth International Congress of Soil Science held in the Belgian Congo in August 1954. Articles on weed control in young rubber areas and on establishment of leguminous ground covers were prepared for publication in *Planters' Bulletin*.

As part of the training scheme for Smallholders' Rubber Instructors, which was held at the Experiment Station, the Soils Chemist gave a course of lectures on soil topics. A course of lectures was also given to groups of Estate Conductors attending courses of instruction at the Experiment Station. Two F.A.O. Fellows from Thailand received tuition in elementary soil science with particular reference to rubber cultivation. The Head of Division gave a lecture to members of the Incorporated Society of Planters at Taiping and at Johore Bahru.

The usual assistance was given to the Technical Education Scheme of the Incorporated Society of Planters by the preparation of examination questions and marking of papers for the soils section of the Agricultural Science examination.

The new extension to the Soils Division was completed and occupied early in the year. In addition to store rooms providing facilities for preparation of leaf and soil samples, this new extension accommodates two senior officers, clerk, typist and the Field Assistants, thus easing the congestion in the laboratory.

The new laboratories and glasshouse designed for extension of pot culture work were completed by August. The glasshouse is an open sided structure supported by slotted aluminium alloy angle (Dexion). It is intended that this should be used mainly for investigations to study the effects of micronutrients; pot experiments with the major nutrients will still be carried out in the open.

Special acid resistant equipment, for the purification of sand by hot acid washing, was erected and put into operation. Sand thus purified was prepared for experiments

planned to study the effect of copper, zinc and molybdenum deficiencies on the growth and composition of hevea.

RESEARCH

MANURING OF HEVEA

Growth measurements were recorded in fiftyfour field experiments and yield records were obtained from forty experiments.

Effect of fertiliser on growth—In a series of experiments designed mainly to study phosphate manuring during the early stages of growth, results showed that mixing of the phosphate (soluble or insoluble) with the top six inches of soil in the planting hole was more effective than surface application or band placement below the surface; the difference due to method of application at time of planting was maintained in the second year of growth and was not affected by post planting treatments. No advantage was gained by increasing the level of application in the planting hole above 4 oz per planting point, nor was there any additional benefit gained by splitting the dosages to allow for more frequent application within the first year whether the total amount used was 4, 6 or 8 oz per planting point. It would appear that an initial dressing of 4 oz in the planting hole, is adequate for normal growth during the first year at least, and possibly longer, for no additional effect due to subsequent applications of phosphate after planting was obtained whether the fertiliser was 'pocketed' or broadcast on the surface and lightly forked into the surface soil. Measurements of heights at various stages of growth up to two years after planting were examined but no differences due to variation in total amount of phosphate applied, varying frequency of application or methods of application after planting were established. There are indications of interaction between methods of application in the planting hole and post-planting treatments but the pattern of response is complicated and the results require confirmation before they can be accepted with confidence. The conclusion of practical interest is that when the initial dressing of phosphate was mixed with the top six inches of soil in the planting hole, no significant additional effect due to subsequent applications of phosphate in the first two years was obtained.

In the series of experiments under discussion, a comparison was made between superphosphate and Christmas Island rock phosphate. The results do not support the suggestion, commonly expressed, that soluble superphosphate is quicker acting than insoluble rock phosphate when used for manuring young rubber plants growing on local soils. It is pertinent to note that the majority of local soils are acid with pH values falling in the range 4.5 to 5.5. The average height of plants at 3 months after planting was significantly greater in the plots receiving rock phosphate than in those treated with superphosphate; this superiority of rock phosphate was unaffected by method of application at time of planting. The height differences due to quality of phosphate were not maintained, and at 6, 9 and 12 months after planting the differences were not significant. A slightly better response to superphosphate than to rock phosphate was observed later in one experiment, when height increments in the second year were examined, but a similar effect was not established in a second experiment where treatments with the soluble and insoluble phosphates are also under comparison.

Rock phosphate was equally effective whether used as a fine powder or as coarser material. For application in the planting hole, four fractions of different particle size

were compared, but there was no difference in effect. However, there was a strong suggestion (not proven) that granular superphosphate applied in the planting hole was more effective early on than the fine grained fraction, although the difference was not maintained; height increments in the second year showed no difference due to particle size.

Application of magnesium (2 oz Kieserite) in the planting hole, and again four months later, produced a highly significant depressive effect on growth of the young plants. The effect persisted up to the end of the first year but height increments in the second year were not affected.

In an experiment designed to study the effect of phosphorus and magnesium on immature PB 86 trees showing symptoms of magnesium deficiency, examination of growth data obtained in the second and third year after treatment showed that there were indications of a beneficial effect due to application of magnesium in the presence but not in the absence of phosphate.

Evidence of a beneficial effect on growth due to treatment with magnesium lime was also observed in a mature rubber area. The trees (clone Pil D65) were showing clear symptoms of magnesium deficiency but the condition of the foliage improved gradually in plots treated with magnesium lime. Treatment commenced in 1951 and was repeated in 1953; a significant beneficial effect on growth in the first and second year was established, but was not continued in the third year.

Further manuring experiments in young areas were started during the year. In one experiment 15 months old budgrafts of clone RRIM 501 were manured in June. Girth measurements taken six months later showed a highly significant response to nitrogen. The new experiments are designed to study the relative effects of different levels and varying frequency of application of nitrogen, phosphate and potash.

In regard to the effect of manuring on growth of mature trees, a clear indication of trends is revealed by analysis of collective data from several experiments. Growth data from two groups of experiments, the 2 x 2 x 2 NPK series and the six-treatment series, comprising 9 and 5 trials respectively, have been analysed in some detail. The records examined cover a period up to the sixth year after commencement of the manuring programme. The trees in these experimental areas were planted during the years 1936 to 1940 and the post-war manuring programme commenced in 1947-1948 after the trees had been tapped for a year or more.

There is clear evidence of a beneficial effect on growth due to treatment with nitrogen and phosphate. The effect becomes apparent in the third or fourth year after the first application, and is more confidently established in the fifth and sixth years. The mean increase due to phosphate in the first six years is of the order of 5 to 6 per cent and that due to nitrogen is 3 to 4 per cent, so the magnitude of the response to treatment with nitrogen and phosphate can be expected to be of the order of 8 to 10 per cent. There is no indication of any effect on growth due to potash in these experimental areas and no interaction effects have been established with confidence.

Data from the other experiments, not included in the two groups mentioned above, show similar trends when examined individually. Where a positive response to manuring is established it is attributable to nitrogen or phosphate or both.

Effect of fertilisers on yields—Yield records from experiments of the 2 x 2 x 2 NPK series and the six-treatment series have been examined in detail. The pattern of responses is only slightly different from that observed when examining growth data from the same experiments. The main difference is that a NK interaction effect is demonstrated; a small beneficial effect due to nitrogen in the presence of potash develops in the third and fourth year after commencement of the manuring programme. No

response to nitrogen in the absence of potash is apparent at this stage, but later on the effect of potash on the nitrogen response diminishes. In the sixth year there is a highly significant response to nitrogen which is independent of the presence or absence of potash. There are indications also of a small but consistent beneficial effect due to phosphate developing in the third or fourth year and continuing in the fifth and sixth years. Application of potash has been without effect, except in so far as its presence may hasten the development of a response to nitrogen.

Results from the other experiments in progress, when examined individually, show similar trends. Where an increase in production as a result of manuring has been established, it is usually due to treatment with nitrogen or phosphorus and sometimes both. Conclusions regarding the relative effects of different levels of application are withheld pending a more detailed analysis of records for the 3 x 3 x 3 and other factorial experiments.

It is perhaps discouraging to find that the magnitude of the responses is so small. The sum of the mean responses to nitrogen and phosphate is of the order of 4 per cent. It may seem that an increase in production of this order is a small return for the heavy expenditure on manuring, but it must be pointed out that this estimate of the magnitude of response to treatment is based on yield records covering a period of only six years after the commencement of the manuring programme, and it is emphasised that the results available now are not fully complete. Records examined to date are the yields obtained by tapping virgin bark; the effect on yield obtained by tapping bark which has renewed during the period when fertilisers were applied has yet to be determined. Manuring must be regarded as a long term project and it will take many years to determine the full effect of treatments on the productivity of the trees.

Effect of fertilisers on seed production—An estimate of the relative seedfall in the different plots of four manuring experiments on estates was obtained during the year. Results showed that applications of phosphate had a beneficial effect on seed production in three out of four experiments, and a similar effect due to nitrogen was established in two experiments. There were indications of a reduction in seedfall in plots treated with potash in two areas.

CULTIVATION AND GROUND COVER

Weed eradication—Spraying trials were carried out to determine the effects of various formulations of the hormone type weed-killers on a mixed population of indigenous growths in a rubber area. The hormone type herbicides tested were: iso-butyl ester of 2,4-D, ethyl ester of 2,4-D, sodium salt of 2,4-D, butyl ester of 2,4,5-T, mixed esters of 2,4,5-T and 2,4-D and the sodium salt of M.C.P.A. (Agroxone 3). Treatments with sodium arsenite and with ammonium sulphamate (Ammate) were included for comparison.

As expected, sodium arsenite caused severe scorching of the leaves, followed by defoliation, of all plants except *Stenochlaena palustris* which was only slightly scorched, but the majority recovered and produced new growth later. It is known from experience that several repetitions of treatment would be necessary to effect complete eradication. Treatment with ammonium sulphamate was even less effective; several plants, including grasses, *Eupatorium odoratum*, *Melastoma polyanthum* and *Mikania scandens*, were severely scorched but regenerated quickly. *Scleria multifoliata* and *Stenochlaena palustris* were only slightly affected.

Of the hormone type weedkillers, the butyl ester of 2,4,5-T and the mixed esters of 2,4,5-T and 2,4-D were the most effective. About twenty different plant species were completely killed by spraying with these herbicides; the successes have chiefly been against woody species including *Melastoma polyanthum*, *Trema sp.*, *Callicarpa longi-*

folia, Bauhinia sp., Grewia umbellata, Santiria griffithii, Solanum verbascifolium, Ficus sp., Macaranga sp., Uncaria pedicellata and *Leea sambucina*. Others which were killed were *Lygodium flexuosum, Eupatorium odoratum, Mikania scandens, Milletia seriacea* and *Rourea similis*.

The esters and the sodium salt of 2,4-D were comparatively less effective, killing about ten different plant species including *Eupatorium odoratum, Mikania scandens, Vitis elegans, Glochidion sericeum* etc. The esters were slightly more effective than the sodium salt, except when used for the control of *Eupatorium odoratum*. Agroxone was least effective, killing only a few woody growths.

Grasses, of course, suffered no serious damage when sprayed with the hormone type weedkillers. Small scale trials to study the effect of other herbicides on the smaller grasses, which are the most troublesome weeds on rubber estates, are in progress. Sodium trichloroacetate applied at the rate of 40 lb in 100 gallons of water per acre was effective in killing dense growth of *Axonopus compressus*; there was no recovery at two months after treatment. Application at the rate of 30 lb per acre was only slightly less effective. Treatment with Ammate (ammonium sulphamate) at rates of 50, 75 and 100 lb per acre was noticeably less effective and regeneration of grasses became apparent after about six weeks. Dalapon (α,α-dichloropropionic acid) is a new herbicide which is under test in the same trials and preliminary results are encouraging. The grasses were completely killed with single applications at rates of 25 and 50 lb per acre, while treatment at the rate of 10 lb per acre was only slightly less effective; no regeneration of growth of the grasses was apparent at two months after treatment but some woody growths which were severely scorched, showed signs of recovery. Trials with dalapon are continuing. As well as being actively absorbed and translocated by living foliage it is also absorbed by roots. Therefore the effect on rubber trees must be investigated and the minimum dosage required for effective control of grasses must be determined before it can be recommended for large scale use on rubber estates. Trials to determine the effect of dalapon on lalang (*Imperata cylindrica*) are in progress.

Control of ground cover and mulching—In an experiment designed to compare different methods of upkeep in an area carrying a stand of two years old budgrafts, results at six months after commencement of the different treatments showed that continuing with strip weeding combined with mulching was most effective, judged on rate of growth of the rubber trees. This treatment was significantly better than either controlling growths in the planting rows by spraying, or allowing covers to spread over the planting rows (minimum control). In this area the ground cover in the inter-row spaces consists of mixed indigenous growths.

Another experiment was started to study the effect of mulching. Results showed that mulching with cuttings of *Mikania scandens* produced a better rate of growth of two years old budgrafts within the first six months after commencement of the treatment; the magnitude of the effect in this short period was of the order of 12 per cent. The benefit due to mulching with lalang and with mixed indigenous growths in the same period was smaller and was not established with confidence. It is accepted that the effect of mulching is likely to be more noticeable when done in younger areas, more especially during the first year of growth of the rubber plants.

Cultivation—An experiment designed to ascertain whether soil cultivation in mature rubber areas has any beneficial or harmful effects on the rubber trees has now been in progress for five years. Cultivation treatments (disc-ploughing and/or disc-harrowing) have been carried out annually since 1950. Growth and yield data for the first four years have been examined. Responses to cultivation treatments are not shown to be significant.

SOIL INVESTIGATIONS

The study of soil physical properties in relation to growth and general performance of rubber trees is still in the exploratory stage. The method for sampling soils for studying their physical properties was re-examined and slight improvements were made. Measurements of percentage pore space and permeability were carried out and it was concluded that reproducibility of results was satisfactory. Physical data have been obtained for soil samples taken at various depths down to 30 inches.

Measurements of the compactness of soils using the Davies Compactometer were made, but because the results obtained with this instrument are difficult to interpret in terms of values for the physical properties of the soil it is considered that this is not a satisfactory short cut method of assessing the physical condition of soils.

Soil conditions under different ground covers including *Pueraria phaseoloides*, *Mikania scandens*, *Axonopus compressus*, *Mimosa pudica* and *Eupatorium odoratum* have been made. Several more observations must be made before the effect of the different ground covers on the physical condition of the soil can be discussed.

PLANT INVESTIGATIONS

Methods and techniques—Various chemical methods for the estimation of nitrogen, sulphur, zinc and molybdenum in leaf material were tested and satisfactory techniques have been developed and put into routine use. Methods for estimating the different nitrogen fractions in dried laminae have been investigated; satisfactory techniques for the extraction and subsequent estimation of ammonia –N, nitrate –N, amide –N and amino –N fractions have been developed and applied for the study of plants grown in the pot-sand-culture experiments. The application of paper chromatography methods for the detection of free amino acids in extracts of fresh leaves revealed the presence of at least twelve acids; the variation of these according to the mineral status of the plant is being examined.

The bioassay procedure using *Aspergillus niger* was applied for the estimation of molybdenum contained in the wet digest of dried laminae. This bioassay method has the advantage of requiring only one-fortieth of the weight of dry laminae required for the chemical method, but owing to its extreme sensitivity, careful manipulation under stringently controlled conditions is essential, and all determinations must be well replicated. Preliminary results obtained seem to indicate that the molybdenum content of plants deficient in phosphorus or potassium may be low, whereas that of plants deficient in sulphur, iron or manganese may be high.

Interclonal differences and seasonal variation in the chemical composition of the lamina of hevea—The early results of this investigation which was started in May 1953 were reported briefly in the 1953 annual *Report*. Monthly samplings of leaves from the three different clones were discontinued after May 1954 and the results of analysis have since been reported fully in the *Journal of the Rubber Research Institute of Malaya*, 14 (1954) 257.

The concentration of rubber hydrocarbon in the petioles and the concentrations of chlorophyll, ash, nitrogen, phosphorus, magnesium, potassium, calcium and iron in the laminae varied according to clone and according to age of leaf (whorl position). The concentrations of rubber, chlorophyll, ash, calcium, iron and manganese increased, while those of nitrogen, phosphorus and potassium decreased, with increasing age of the leaves. This effect of whorl position (or age of leaf) on concentration of rubber in the petioles, and of chlorophyll, phosphorus and calcium in the laminae, varied according to month of sampling but, except for rubber concentration, this seasonal variation was consistent for all three clones. Incidence of rain fall was partly respon-

sible for the seasonal variation in the rubber, nitrogen and iron concentrations. The importance of whorl position and seasonal variation in making valid comparisons of nutrient status based on leaf analysis was indicated.

The concentration of rubber in the petioles varied according to the nitrogen concentration of the laminae, which in turn, was influenced by the calcium concentration. The concentrations of both nitrogen and rubber increased with increasing rainfall.

POT CULTURE EXPERIMENTS

The newly erected glasshouse and nutrition laboratories were used during the second half of the year for pot culture investigations. The glasshouse is used mainly for experiments planned to study the effect of copper, zinc and molybdenum deficiences on growth and composition of hevea. Experiments with the macronutrients continued in the open air in a wired enclosure.

A large scale supply of water suitable for micronutrient deficiency experiments was obtained by the demineralisation of rain water by means of ion-exchange resin units. For certain treatments this supply was augmented with water distilled from pyrex glass stills.

Survey of nutrient deficiency symptoms—The effects of withholding each of nine nutrient elements was discussed in the 1953 annual *Report*. In this first experiment the observations were made on seedlings grown from selfed Tjir 1 seeds. A similar experiment was carried out in 1954 using seedlings grown from seeds collected from budgrafted PB 86 trees. The purpose of the experiment was to confirm previous results and to find out whether PB 86 seedlings responded in a similar manner to Tjir 1 seedlings. For ease of comparison some Tjir 1 seedlings were grown alongside the PB 86 plants in a few of the treatments.

Leaf deficiency symptoms were observed in the –N, –P, –Mg, –K, –Fe and –Mn plants; effects believed to be due to deficiencies of calcium and boron were also observed. Under the conditions of the experiment, PB 86 grew more vigorously than Tjir 1 plants receiving the same treatments. The PB 86 plants showed potassium deficiency symptoms which were quite as severe as those of Tjir 1 and the potassium concentrations in the potassium deficient laminae were similar for both clones. The concentrations of magnesium found in the magnesium deficient laminae of both clones were roughly the same, yet the PB 86 plants appeared to retain their magnesium deficient leaves longer than the Tjir 1 plant and, for this reason, may be regarded as being better indicators of magnesium deficiency. This may explain why symptoms of magnesium deficiency in the field are observed much more frequently in PB 86 areas than in other clonal blocks. In regard to the effect on growth, the Tjir 1 plants suffered more severely as a result of magnesium deficiency, the plants being thinner and smaller, but because of the early leaf fall the visual symptoms were not so obvious.

No other noticeable differences in response to nutrient deficiency between the two clones were observed, except that hitherto the effect of calcium deficiency appears to be more severe in the Tjir 1 plants than in the PB 86 plants.

The interrelationship of Mg, K and P—The experiment designed to study the interrelationship between Mg, K and P was terminated in October 1953 and observations were reported in the 1953 annual *Report*. Further analytical data examined since show that increased level of added magnesium decreased the manganese content of the laminae, whereas increased supplies of either potassium or phosphorus increased it. The positive effects of potassium and phosphorus on manganese content were more pronounced at the lowest magnesium levels, thus MgK and MgP interaction effects were established.

Magnesium-manganese interrelationships—In view of observations mentioned in the preceding paragraph it was considered that it would be of interest to examine further the interrelationships between magnesium and manganese. The high acidity of Malayan soils, and the comparatively high content of available manganese commonly found in these soils, suggest the possibility that this element might influence the changes associated with magnesium deficiency in hevea.

Tjir seedlings were grown in a factorial experiment with three levels of magnesium and three levels of manganese. The experiment was started in March 1954 and is still in progress. For the first six months all the nitrogen was supplied as nitrate but afterwards 3/8 of the total nitrogen in the solution was supplied in the form of ammonium salt.

Manganese deficiency symptoms appeared at the lower manganese levels and increased in severity as the magnesium supply was raised. Magnesium deficiency symptoms were observed mainly in plants grown at the lowest magnesium level (Mg_1); there have been no indications, hitherto, that the severity of the symptoms increased with increasing levels of manganese. In the early stages of the experiment, increasing supplies of manganese had a beneficial effect on dry weight of the plant, but later on manganese exercised a depressive effect which was most marked at the highest magnesium level. The overall effect of magnesium, manifested in the form of increased dry weight, was apparent throughout, and was usually most marked at the deficiency level of manganese.

The potassium concentration in the laminae decreased with increasing levels of both manganese and magnesium, but the differences due to the former were small in comparison with those due to the latter. The phosphorus concentration in the laminae also decreased with increasing levels of manganese while increasing the supply of magnesium resulted in a marked decrease of the manganese concentration in the leaves.

Thus the marked effect of magnesium levels on the accumulation of manganese in the laminae was confirmed and shown to to be related to the severity of manganese deficiency symptoms. Varying the supply of manganese did not affect directly the concentration of magnesium in the leaves.

Source of nitrogen experiment—An experiment designed to investigate the effect of different levels of ammonium- and nitrate-nitrogen on growth, rubber content and mineral composition of Tjir 1 seedlings was started in December 1953. Three levels of each of the two sources of nitrogen were chosen to represent deficiency (Am_1 and N_1), mild deficiency (Am_2 and N_2) or normal consumption (Am_3 and N_3). Calcium was supplied at two levels, low and normal.

Nitrogen deficiency symptoms were observed first in the Am_1 N_1 plants and later on in the Am_1 N_2 and Am_2 N_1 plants. Seedlings receiving the high levels of ammonium and calcium showed well marked symptoms of magnesium deficiency in the early stages of growth but these symptoms became less noticeable later on.

Both ammonium and nitrate addition increased girth, but whereas the girth of N_3 plants was larger than that of the N_2 plants, the Am_3 Ca_1 plants were smaller than those receiving the Am_2 Ca_1 treatment. The observations suggested that increasing amounts of ammonium in the Ca_1 treatments caused a mild toxic effect which was not apparent for nitrate at the same levels.

In terms of dry weight per plant the response to nitrate is greater than that to ammonium nitrogen, and the effect was greatest in the presence of calcium at the higher levels.

In general, the concentration of rubber in the stems, petioles and laminae decreased, whereas the chlorophyll concentration of the laminae increased with increasing levels of ammonium– or nitrate-nitrogen; the overall effect on chlorophyll concentration was greater with ammonium than with nitrate.

The concentrations of nitrogen, phosphorus, potassium, magnesium and calcium in the laminae varied according to the form and amount of nitrogen added. The differential effect of source of nitrogen on the various nitrogen fractions in the laminae suggested that some ammonium ions must have been absorbed unaltered.

The vigorous and healthy growth with some of the treatments indicated the possibility that good growth of hevea in sand culture may be obtained only when ammonium ions are present in the nutrient solution. Another feature of interest was the fact that, despite the close similarity in appearance and dry weight of plants grown with different combinations of ammonium and nitrate nitrogen, the calcium concentrations in the laminae may vary considerably owing to the differential effect of ammonium and nitrate supplies on calcium content.

There is a suggestion that the incidence of fungal leaf disease may be related to the mineral status of the plant. The incidence of infection by *Helminthosporium heveae* appeared to increase with increasing levels of either ammonium or nitrate nitrogen, but this point is being investigated further.

ADVISORY

The volume of advisory work was slightly less than in the previous year. The statistics relating to advisory correspondence, visits and interviews may be summarised as follows:

Letters and reports despatched	413
Visits to estates	65
Interviews at the Institute	95

Manuring

Enquiries covered a wide field but, as in previous years, the subject requiring most attention was manuring of immature and mature rubber. The possibility of improving or maintaining yields of old unselected seedling rubber trees by manuring is still being considered on some estates, and the economic aspect of manuring low yielding material with limited potentialities has been the subject of correspondence on several occasions, but a large majority of enquiries referred to young immature areas and to the older areas planted with high yielding clones and seedling families. Symptoms of magnesium deficiency, both in young and mature trees, were frequently observed and it would appear that there is an increasing need for using magnesium lime, or fertiliser mixtures containing magnesium, in rubber areas. It is difficult to explain why magnesium deficiency in rubber has become more prominent in recent years; it may be due to more liberal and more regular use of phosphate fertilisers, as high phosphorus concentration in the tissues can induce symptoms of magnesium deficiency. There has been very little evidence in the past to suggest that large scale applications of potash would be beneficial except on very sandy soil, but clear symptoms of potassium defi-

ciency in the field were observed for the first time on other types of soil during the past year. There is evidence to indicate that iron deficiency may be a more common cause of nutritional disorder in rubber than was previously thought.

Early in the year, interest was aroused in a suggestion that leguminous creeper grown as ground cover in rubber areas may respond to treatment with molybdenum. Several letters were received asking for information, and for advice on methods and rates of application of molybdenum, but interest in the subject waned towards the end of the year. No convincing evidence of any beneficial effect was observed in small scale trials carried out at the Experiment Station, and no reports of successful results due to treatment have been received from estates.

Control of Ground Cover

There was a marked reduction in the number of enquiries concerning eradication of lalang while requests for advice on control of other grasses increased, more especially those grasses which are not effectively controlled by sodium arsenite. These include the bamboo-like grasses such as *Ischaemum muticum, Panicum sarmentosum* etc. and sedges.

Methods and degree of control of ground cover is another subject which seems to be receiving more attention judging from correspondence. The trend is towards less rigorous control of creeping cover in replanted areas about 18 months or 2 years after planting, or after budding in the field. The need for continued control of grasses and other undesirable types of ground cover is generally appreciated, but it is felt that continued maintenance of clean weeded strips along planting rows throughout the period of immaturity may not be necessary in areas where the ground cover consists almost entirely of creepers.

Examination and analysis of samples—The number of soil samples received for examination continued at about the same level. These samples are usually examined with the object of identifying soil type so that advice can be given on suitability for planting or replanting, manuring, and on type of planting material. Chemical analysis of the soil samples is not necessarily carried out, except for more specific purposes, for experience has shown that this, by itself, gives little information of value for assessing the fertility of local soils or for diagnosing the cause of backward growth of rubber plants. More emphasis is placed on the value of foliar diagnosis for investigating nutrient deficiency problem in the field. The more recent work done in the Division on nutrition of rubber, using the pot culture technique, has provided information which makes it possible to identify symptoms of nutrient deficiency with more confidence and which allows for more reliable interpretation of the results of chemical analysis of leaf samples. There has been a marked increase in the number of leaf specimens brought in from estates for examination and analysis.

Visits to Estates—The majority of visits to estates were made in response to requests to investigate the causes of backward growth or abnormal defoliation in young rubber areas and to advise on manuring of both mature and immature trees. Visits were made to an estate to discuss, and carry out, cooperative work in laying out field experiments in a large area prepared for replanting by mechanised equipment.

Exchange of correspondence with the Manager of an estate in South Johore, who has experimented with new innovations in replanting technique, led to stimulating discussions when the estate was visited to view the results. The modifications which were introduced into replanting procedure on the estate in 1953 are based mainly on the recognition of the importance of organic matter in the cultivation of crops in tropical soils. The basic principles are well known and the beneficial effect of organic matter was never in doubt, but this is the first time that a serious attempt was made to make liberal use of available sources of organic matter in large scale replanting of rubber areas

(the technique followed included other minor modifications not directly connected with the use of organic matter). In this particular instance, the main interest lay in the practical application, in large scale work, of certain well known basic principles of cultivation.

G. Owen
Head of Soils Division

Botanical Division

The Head of Division with Dr J. S. Lowe, Dr P. R. Wycherley, Mr T. V. Vaidvanathan and Mr V. K. Bhaskaran Nair were on duty throughout the year. Mr H. M. Burkill resigned with effect from 24 May on appointment as Assistant Director, Botanic Gardens, Singapore. Dr P. R. Wycherley has taken over the development work of the breeding programme and the testing of clones and seedling families in large scale estate trials, following upon the resignation of Mr Burkill.

Two Senior Officers resumed duty during the year on their return from home leave, Mr C. W. Brookson on 27 March and Mr P. de Jonge on 29 July. Mr de Jonge was granted one month study leave whilst on long leave during which time he visited the Botanical laboratories of Utrecht, Wageningen and Groningen Universities. He also visited the Agricultural Department of the University of Oxford.

Two members of the Junior Staff reported for duty during the year on their return from long leave, Mr S. Karalasingam on 4 March and Mr O. Karunakaran on 23 February. Mr R. Perumal was on long leave from 1 March to 6 June and Mr F. P. Ignatius from 19 April to 19 July. Mr R. Nithianathan, Laboratory Assistant, returned to the Division on 5 March after secondment to the Statistics Section since 1 December 1953. He resigned on 1 July to take up school teaching.

Mr Chow Yoke Cheong was appointed as field assistant on 1 July. He resigned on 31 October to take up an appointment as an Estate Cadet with an important Group of Rubber Companies. This vacancy was filled by the appointment of Mr Tan Lee Yeong who assumed duty on 1 November.

The articles 'Tapping Systems', 'Basket Planting', 'Tapping Prior to Replanting', 'A Speculation in Seed' and the editorial 'Rubber from West to East', contributed by the Botanical Division, were published in the *Planters' Bulletin* during the year. Two leaflets 'Latex Yield Stimulation with 2,4,5-T' and 'Poisoning of Rubber Trees with 2,4,5-T" were issued for use in advisory correspondence.

Dr E. D. C. Baptist lectured on 25 February, to R.R.I. Staff Colloquium on 'The Work of the Botanical Division'; 10 April to Central Selangor Branch of Incorporated Society of Planters on 'Yield Stimulation'; 30 April to Senior Conductors Course R.R.I. Experiment Station on 'Planting Material and Tapping Systems'; 9 May to North Selangor Branch of the I.S.P. on 'Problems of Current Interest on Estates'; 10 May to Dindings District Planting Association on 'Problems of Topical Interest'; 19 May to Johore Planters' Association (West Section) on 'Yield Stimulation'; 17 June to Kelantan Branch of the I.S.P. on 'Problems of Current Interest on Estates'; 15 August to Negri Sembilan Branch of the I.S.P. on 'Yield Stimulation'; 20 August to North Johore Branch on 'Problems of Current Interest on Estates'; 22 August to Central Johore Branch of the I.S.P. on 'Problems of Current Interest on Estates'; 30 August to South Johore Branch of the I.S.P. on 'Problems of Topical Interest'; 14 October to Kuala Selangor Branch of the I.S.P. on 'Problems of Topical Interest' and on 22 October to Kedah North and Central Branch of the I.S.P. on 'Problems of Tropical Interest'.

Mr C. W. Brookson lectured in September to North Johore Branch of the Incorporated Society of Planters on 'Improvement of Hevea'; on 29 November to South Johore Branch of the Incorporated Society of Planters on 'Improvement of Hevea' and 31 December to R.R.I. Staff Colloquium on 'Points of Interest Arising out of the Plant Breeding Programme.'

Mr P. de Jonge gave the following three lectures on 'Yield Stimulation'; 27 August to R.R.I. Staff Colloquium; 13 September to Dindings District Planters' Association and 20 October to North Johore Branch of the I.S.P.

Visits to estates in connection with experimental planting totalled 86 and field assistants spent 405 days on 106 visits to experimental areas on estates.

Graduate Officers paid 322 visits to the R.R.I. Experiment Station and field assistants from headquarters worked on the Experiment Station for 17 days.

RESEARCH

BREEDING, SELECTION AND TESTING

Hand Pollination

Weather conditions during the short main flowering season of the first half of the year were particularly unfavourable for good fruit set and the percentage of pollination successes was only average. The germination results were below average.

A series of new legitimate seedling families were obtained from 6492 hand pollinations representing twelve different crosses. Ten of these families were obtained by crossing clones of the RRIM 600 Series and clone RRIM 527 with clones AVROS 157, PR 107, War 1 and 4, reputed to be good seed parents in their country of origin.

The programme of back crosses, out crosses and selfs outlined in the 1950 programme has now been completed. The final results of the 1954 hand pollination programme are set out below.

Cross	No. of pollinations made	% of pollination successes	No. of seeds germinated	% of germination successes
AVROS 157 x RRIM 527	326	9.2	48	53.3
AVROS 157 x PB 49	282	—	—	—
AVROS 157 x PR 107	112	—	—	—
PR 107 x RRIM 605	321	6.5	35	55.5
PR 107 x RRIM 600	540	0.9	5	33.3
PB 49 x RRIM 527	41	9.8	6	50.0
War 4 x RRIM 600	1180	2.5	80	88.9
War 4 x RRIM 616	1199	4.6	130	78.8
War 4 x RRIM 605	287	5.2	5	11.9
War 1 x RRIM 616	1042	3.3	86	84.3
War 1 x RRIM 605	696	1.3	15	55.6
PB 49 x RRIM 603	458	4.1	36	63.2
Total	6492	3.4	446	57.5

The crosses AVROS 157 x PB 49 and AVROS 157 x PR 107 were found to be completely sterile while the crosses AVROS 157 x RRIM 527 and PB 49 x RRIM 527 showed above average compatibility, with pollination successes of over 9 per cent.

The lowest pollination successes were obtained with the crosses PR 107 x RRIM 600 and War 1 x RRIM 605 which gave 0.9 and 1.3 per cent successes respectively.

An experiment was carried out to investigate the amount of seed set occurring in a monoclone block of clone Pil B84. In hand pollination work clone Pil B84 was found to be almost completely self sterile but in this monoclone block seeds, albeit in small quantities, an average of three seeds per tree, were found in the centre of the block ten clear chains away from the nearest other rubber. About double the number of seeds of clone Pil B84 per unit area were found near the boundaries with other clones or with old seedling rubber but the number was still less than one tenth of that normally found in a field of clone Tjir 1.

An interesting point brought out in this experiment is that when the ripe fruit bursts the maximum distance at which the seeds are flung does not exceed one chain and it may be substantially less.

A study of the chromosomes of *Hevea brasiliensis* was started late in the year with the aid of a phase contrast microscope.

Promising results for an accurate count of the number of chromosomes have been obtained using squash preparations of the basal portions of very young leaves stained with 2 per cent orcein in acetic acid. The stain provides an intensive contrast but blurrs the internal structure of the chromosomes.

Methods of Early Selection—The examination of criteria for the early selection of potentially high yielding individuals continues. A 'preliminary test' method of yield prediction has been carried out on two years old buddings of 300 clones made from legitimate seedlings of the 1949 series of crosses and the data have been summarised for statistical analysis. Measurements of sieve tube diameter have been made on bark samples from these young buddings and also from the bark of 211 legitimate seedlings of the 1951 series of crosses.

Bark samples have been collected from 440 seedlings of the 1952 series of crosses (families 1 to 13) and fixed in formalin-acetic-alcohol for sectioning and measurements of sieve tube diameter.

The examination of the sieve tube diameter of the bark of trees used by H. Gunnery in his anatomical studies at the R.R.I. in 1935 for selecting high and low yielders was completed during the year. Bark samples collected at the junction of virgin bark and bark of second renewal of four R.R.I. clones showed, on sectioning and examination, an average of 55 latex vessel rows of which 44, or 80 per cent, run through both virgin and renewed bark while 11, or 20 per cent, are interrupted at the junction of virgin and renewed bark. This observation may, in some measure, explain the fall in yield generally experienced near the junction of virgin and renewed bark.

Seedling Families

Few seeds were obtained during the year from the seed gardens of approximately 190 acres established on the R.R.I. Experiment Station under the Colonial Development and Welfare Scheme D1176 for the provision of high grade seed for the use of smallholders. It is expected that seed from these gardens will be available in larger quantities in 1955 when the oldest garden will be in its fifth year from budding.

Four hundred and sixtyfour legitimate seedlings of the 1952 hand pollination programme, representing thirteen families, were planted out 30 ft x 12 ft in the first clearing of the new reserve land (Field 58A, 10.75 acres) during November. The planting holes had received 14 lb of cow dung. The boundary rows of this trial area were planted with legitimate seedling stumps of clone Tjir 1. The trial is in three replications, with each of thirteen legitimate seedling families represented in each replication, and consists of single-tree plots.

The balance of 64 acres of this new clearing was lined 30 ft x 8 ft and planted with two seedling stumps per 18 inches cube hole for budding in 1955.

In the trial of the legitimate seedlings of the 1937 hand pollination programme, family Pil B84 x AVROS 157 remained the highest yielder in 1954 with 33.9 lb per tree per year followed by families AVROS 157 x PB 49 (31.9 lb), PB 24 x AVROS 157 (31.3 lb), Tjir 1 x PB 49 (31.0 lb), Tjir 1 x PB 24 (27.2 lb) and AVROS 157 x Tjir 1 (25.5 lb).

The brown bast incidence, as a percentage of tapped trees, has been 42, 16, 94, 37, 58 and 50 respectively for the period 1946—1954. The lowest yielding family is Tjir 1 x PB 86 which yielded 9.8 lb per tree in 1954 compared with a yield of 14.2 lb for the control clone Pil B84 which has had a brown bast incidence of 19 per cent to date.

In the trial of the 1938 hand pollinated seedlings the six highest yielding families during the year were Tjir 1 x Tjir 16 (25.2 lb), RRIM 507 x Tjir 1 (24.7 lb), RRIM 504 x Tjir 1 (21.7 lb), RRIM 501 x Tjir 1 (21.1 lb), RRIM 509 x Tjir 1 (20.3 lb) and RRIM 511 x Pil B84 (18.9 lb) compared with a yield of 13.1 lb per tree year for the control clone Pil B84. It is noted that family RRIM 509 x Tjir 1 which has been the highest yielder from 1946 to 1953 with a mean yield of 26.6 lb per tree year has in 1954 fallen to fifth place. Brown bast incidence, as a percentage of tapped trees, has been 64, 79, 61, 52, 40 and 29 respectively compared with 17 for the control clone Pil B84.

Of the legitimate seedlings of the 1939 series of crosses family Lun N x Tjir 1 remains the highest yielding with 19.0 lb per tree per year folowed by family Tjir 1 x Pil B84 with 13.8 lb, both families showing a considerable decrease over the previous year. The control buddings of clone Pil B84 yielded 13.1 lb per tree during the year under review. Brown bast incidence to date was 60, 54 and 17 per cent respectively.

The trial of the 1940 hand pollinated seedlings showed families Tjir 1 x RRIM 526, Tjir 1 x RRIM 528 and Pil B84 x RRIM 501 to be the highest yielding with yields of 23.1, 22.0 and 20.7 lb per tree respectively and with a brown bast incidence to date of 28, 32 and 10 per cent respectively.

Of the seedlings of the 1941 crosses the most promising family to date is Tjir 1 x RRIM 509 with a mean yield in 1954 of 21.1 lb per tree per year and a mean brown bast incidence of 10 per cent for the period 1950 to 1954.

In the oldest trial of Isolation Garden seedlings, from an Isolation Seed Garden on Batu Kawan Estate, seedlings of clones AVROS 157 and PB 25 remain the highest yielding with a mean yield of 19 lb per tree per year for the period 1946—1954. The brown bast incidence during the same period has been 13 and 19 per cent respectively.

Clones

Fiftyfive new clones in small scale trial on the R. R. I. Experiment Station were taken out of yield recording during the year. Of fiftytwo clones of which yields are still being recorded only twentyeight were considered worthy of another inspection and it is not expected that the number to be finally selected in 1955 for large scale trial will exceed six.

Four hundred and fortyone new clones made from the legitimate seedlings of the 1952 series of crosses were budded in Field 57 R.R.I. Experiment Station in November in a square lattice design with two replications giving an initial number of twelve trees per clone. The seedlings in the boundary rows were budded with clone RRIM 501.

The terms of the international clone exchange, agreed by the Liaison Committee of the Directors of Rubber Research Institutes at a meeting in Bogor in March and approved by the Board of the R.R.I. of Malaya, were implemented during the year when twenty clones were received from each of the Rubber Research Institutions of Java, Sumatra, Ceylon and Indochina. These clones represented the best of the recent selections in these countries. The exchange clones (five metres of budwood of each clone) received from Ceylon in August and December, from Indochina in August and from Java and Sumatra in November were budded in the nursery at the R.R.I. Experiment Station on arrival.

Budwood of twenty RRIM clones for exchange was despatched to the Rubber Research Institute of Ceylon on 10 August, to the Institut des Recherches sur le Caoutchouc en Indochine on 10 August, to the Proefstations der Centrale Proefstations Vereniging on 10 November and the Algemeen Proefstation der A.V.R.O.S. on 18 November.

Two hundred and sixteen clones made from seedlings of a seed importation from Tropical America, R.R.I. Imported Seedlings Collection, were budded in a trial of cubic lattice design on the R.R.I. Experiment Station in May. Eightyseven other clones of the same origin were budded in a small scale trial during July. A consignment of one yard of budwood each of 140 of these clones was despatched to the Rubber Research Institute of Ceylon in June.

Twelve Dothidella resistant clones, namely F 409, F 4537, FB 3363, F 1619, FX 360, FX 664, FX 232, FX 636, FB 3300, F 351, FX 4037 and FX 714 were budded in June in a discard area of Field 48, R.R.I. Experiment Station and one bed each of eighteen of these Dothidella resistant clones has been budded in a multiplication nursery. These 18 Dothidella resistant clones have been topworked during June on to branches of 3½ years old trees of clone Gl 1, six trees to each Dothidella resistant clone, with a view to providing early flowering for breeding purposes.

Six Dothidella resistant clones received from the Plant Introduction Garden of the U.S. Department of Agriculture at Miami, Florida in July, namely FX 273, F 516, F 617, F 1168, FX 2831 and FX 4421 gave 91.2 per cent final budding successes and another two clones namely F 406 and F 4542 received in December gave 72.2 per cent budding successes. These 8 clones comprised the balance of the 25 clones exchanged by the R.R.I. of Malaya with the Instituto Agronomico do Norte, Belem, Brazil for the same number of R.R.I. clones and the exchange is now completed. Budwood of these clones had been multiplied under quarantine conditions at Coconut Grove, Miami and was flown to Malaya via the Commonwealth Mycological Institute, Kew where it was examined and disinfected. The Rubber Research Institute of Malaya through the Directors' Liaison Committee has agreed to supply budwood of these twentyfive clones to Rubber Research Institutes in Ceylon, Java, Sumatra and Indochina.

The large scale trial of the RRIM '500' series clones on the R.R.I. Experiment Station continues in recording. Tapping has been on bark of first renewal since January 1953. Clones RRIM 501 and 513 remain the highest yielders in this trial, the average yield for the period 1946 to 1954 expressed as lb per acre per year being 2131 for clone RRIM 501 (control clone Pil B4 yielding 1310 lb) and 1972 for clone RRIM 513 (control clone Pil B84 yielding 1044 lb). Clone RRIM 501 is the more vigorous of the two clones and has shown a pronounced susceptibility to pink disease.

Clones RRIM 511 and 519 yielded during the same period 43 and 42 per cent more than the control clone Pil B84, the latter being tapped at 67 per cent intensity since May 1948 because of a high incidence of brown bast. The brown bast incidence in clones RRIM 501 and 513 during the full period of nine years' continuous tapping on the half spiral alternate daily system is 18 per cent of tapped trees.

In the large scale trial of clones RRIM 523 to 529 the best yields have been obtained from clones RRIM 526 and 527 which gave an average yield of 1536 and 1647 lb per acre per year for the period August 1947 to July 1954 compared with one of 1014 lb for the control clone Pil B84. Most clones in this trial showed a large fall in yield when tapped from 19 inches to 9 inches from the union on virgin bark of the second panel during 1954. The percentage incidence of brown bast during the full period of continuous tapping on the S/2.d/2.100% system was 14 per cent in both clones RRIM 526 and 527.

Of these two clones RRIM 527 is the higher yielder but it is less vigorous than clone RRIM 526, has latex of low mechanical stability and may with increase of age develop heavy woody burrs on the main stem. For these reasons it is no longer recommended for use on a commercial scale.

The RRIM '600' series clones in a small scale trial have completed their eighth year of tapping and yield recording. Increases in yield during the year are shown by clones RRIM 601, 605, 607, 615 and 620, other clones showing either little change or, in a few cases, an actual decrease.

Trees of clones RRIM 624, 625, 626 and 627 in Field 42 of the R.R.I. Experiment Station, on a jungle boundary, which were taken out of tapping after bark slashing by terrorists in June 1951 were brought back into tapping with associated controls in January 1954 on cuts opened above the damaged bark at 50 inches from the union.

In the large scale trial of these clones the best growth at the end of the year in Field 48A is shown by clones RRIM 613, 603, 601, 612, 602, 606, 607 and 616 and in Field 48D clones RRIM 623, 621 and 625 have made the most vigorous growth. A severe windstorm, which occurred during the night of 4 March, caused some damage in a few plots of this large scale trial, particularly near the north eastern boundary. Clones RRIM 613, 616, and 603 were the most affected.

Clone RRIM 618 made from a seedling of the cross Lun N x RRIM 501 (a back cross) would seem to have inherited from its male parent a susceptibility to pink disease; an incidence of 52.4 having been recorded during an outbreak of the disease in November. The average incidence for the other '600' series clones did not exceed 3 per cent.

The RRIM 600 series clones in greatest demand by estates during the year were RRIM 603, 612, 602, 605, 615 and 600 of the first selection and RRIM 623, 622 and 621 of the second selection. In order to meet the increasing demand for budwood fifty additional beds of the RRIM 600 series clones were established in a multiplication nursery on the R.R.I. Experiment Station during the year.

The results of tests on rubbers of the RRIM 600 series clones carried out in the Chemical Division of this Institute from May 1953 were not available at the end of the year for inclusion in the report.

A second collection of latex of these clones was made during the last quarter of the year for tests of mechanical stability. A full report on these tests will be given in the annual *Report* for 1955.

The suitability of latices of a number of other clones for preparing latex concentrate has been examined in our Chemical Division. Concentrate prepared from latex of clone RRIM 501 from four sources on both inland and coastal soil, the age of the trees varying from seven to seventeen years, showed a high mean value of 1189 seconds after three months' storage, the values ranging from 740 to 1703 seconds which are well above the specifications of the American Society for Testing Materials The mean value after one month's storage was 360 seconds. The corresponding values after three months' storage for clones RRIM 513, 526 and 527 were 1402, 940 and 300 seconds.

Latex concentrate of clone PR 107 from two estates gave the low values of 147 and 191 after three months' storage. The concentrate from a third estate gave a value of 772 seconds. Further experiments are in progress with latex of this clone.

Latex concentrate of the Prang Besar Clones 5/37, 5/51 and clone Sabrang 24 gave values of 303, 949 and 1464 seconds respectively after three months' storage.

Experimental Planting On Estates

Full data for the first five years of continuous commercial tapping of these field trials have been summarised and statistically analysed by Mr H. M. Burkill, who was in charge of the estate trials from July 1948 to May 1954.

During 1954 the trials on four coastal soil estates continued in recording. There were two standard clones trials (153 acres), three subsidiary clones trials (36 acres), four RRIM 500 series clones trials (159 acres), two clonal seedling trials (91 acres) and one stock/scion experiment (26 acres).

On inland soils two standard clones trials (138 acres), two subsidiary clones trials (27 acres), nine RRIM 500 series and new clones trials (301 acres), seven clonal seedling trials (352 acres), one method of planting experiment (56 acres) and one density of planting experiment (80 acres) have been in recording on 14 estates during the year. Of these one RRIM 500 series trial (50 acres) has been brought into recording after being out of recording for six years, due to labour and emergency difficulties. Due to various difficulties the trials on two of the above estates have been discontinued as they were considered to be of no further value. These include a standard clones, a subsidiary clone, a clonal seedling and a new clones trial (total 168 acres).

As an economy measure twentyfour pre-war trials in which yield recording by the method of cup coagulation had hitherto been carried out on two days in each month have had yields recorded only once monthly since the beginning of the year.

Since the war and up to the commencement of 1954, 103 acres on twentyone cooperating estates have been planted in a distributed block trial of 13 RRIM 600 series clones. A further 425 acres on 19 estates have been planted with promising clones of the RRIM 500 series, 600 series and new commercial clones. During the

year another 6 estates have devoted 80 acres to the testing of the RRIM 600 series clones. As a result every RRIM 600 series clone is represented twice on inland soil and once on coastal soil. This is not adequate, but approximately half these clones are sufficiently represented on inland soils. With the exception of one estate, all the trials in recording have been visited during the year.

Girths are measured at two years from cutting back. Seven estates with distributed blocks and eleven estates with complete trials have been visited for this purpose during the year.

The number of yards of budwood of RRM '600' series clones despatched to nine estates for use in clone trials during the year was 2811 yards. Five hundred and thirty letters were received and 317 letters were despatched during the year in connection with experimental planting on estates. Field Assistants paid 106 visits and spent 405 days on estates for routine inspections and recording of growth measurements in experimental areas.

Wintering effects—The small-scale trials of the RRIM 600 series clones on the R.R.I. Experiment Station were observed during the 'wintering' period. The parents of these clones, including Tjir 1 and PB 86, were also observed.

Trees of clone PB 86 were bare during the last week in February and those of clone Tjir 1 defoliated nearly two weeks later. The wintering of the latter clone was less uniform. The wintering of clones RRIM 619 and 629 was too indefinite to be dated, and BD 5, one of the parents of clone RRIM 609, was defoliated by *Gloeosporium* and its period of wintering could not be estimated. Of the remaining 28 RRIM 600 series clones, 7 wintered before their parents, 6 wintered within the range of their parents, and the other 15 wintered later than their parents. Twenty 600 series clones wintered at the same time as or later than clone Tjir 1. These results only apply to conditions during the one season, but suggest that these selected clones tend to winter late. This appears to be true of clones RRIM 501 and 513 also.

Forty estates sent reports on wintering in clones PB 86 and Tjir 1, together with rainfall records from various parts of Malaya. On the whole clone PB 86 wintered earlier, more heavily and uniformly than clone Tjir 1, but there were exceptions to this.

In Johore, Pahang, along the East Coast and in the Bahau district of Negri Sembilan wintering was either not uniform in the stands observed, or nearby estates reported widely differing dates of defoliation. However, in general, wintering in these areas was earlier in the north (early February) than in the south (March) and it was intermediate between. Estates in Kedah reported clones PB 86 and Tjir 1 wintering during the first half of February, Tjir 1 defoliated slightly later than PB 86.

The records received from Perak were interesting. A group of estates near Sungei Siput remarked that this was the most complete defoliation experienced since the Occupation. Clone PB 86 wintered from late January to early February and clone Tjir 1 in early February. On the estates of the Perak coast, from Matang to Teluk Anson and including the Dindings, wintering was four to seven weeks later than in the Sungei Siput area. Intermediate dates of wintering were received from estates between these two areas. In the Sungei Siput area the rainfall records show that the second week in January was dry, whereas the depression in rainfall during this period was less pronounced in the coastal records.

Estates in Negri Sembilan and Selangor reported various dates from early February to mid-March for the two clones concerned. Clone PB 86 was usually earlier, but it was not possible to discern any clear pattern in this area. A single estate at Muar, in North West Johore, reported clone PB 86 wintering in late January.

The observation of wintering is subjective, and it is not surprising that there is some variation between the observations of nearby estates. However, if their rainfall charts are compared, astonishing differences both in the amount of rain and the dates on which it fell are revealed in many cases. The climate of Malaya is, in this respect at least, very local.

It was not possible to find any clear correlations between rainfall and the commencement of defoliation. In Kedah a long rainless period was experienced during December 1953, but defoliation did not begin until late January and most estates reported wintering in early February. This is explicable by the senescence theory of Ch Coster (Ann. Jard. bot. Buitenz. 13 (1923)117). In this case it must be assumed that in December the individual leaves were not yet senescent and sensitive to external influences stimulating leaf fall, but they were during the dry periods in January and February.

Secondary leaf fall, due to parasitic attacks, was reported in several instances where refoliation was taking place during a period of heavy rainfall.

The study has not yielded new facts, but confirmed the general pattern already known. The cooperation of the estates concerned is gratefully acknowledged.

PROPAGATION AND PLANTING TECHNIQUE

Further attempts to provide the conditions for the rooting of leaf cuttings of hevea of different ages, with and without an axillary bud have been unsuccessful. The leaf petioles were treated by the instantaneous dip method with a solution of a mixture in equal proportions (0.04 gm) of alpha naphthaleneacetic acid and beta indolylacetic acid in 10 ml of 50 per cent ethyl alcohol.

After treatment with the synthetic growth substances the leaf petioles were inserted in a rooting medium of a 1:2 mixture of sand and peat moss contained in a miniature glasshouse (Chase electric seed raiser) in which a virtually saturated atmosphere was maintained. The temperature in the glasshouse ranged from 24°C at 8 a.m. to 30° at 4 p.m.

Preliminary trials with a view to increasing the percentage of successes on transplanting of stumped buddings, by cutting down the loss of water from the bark, have shown that painting the stem with proprietary mixtures of polymethyl methacrylate and latex or covering the stem with alkathene or grease proof paper or newspaper have a beneficial effect on the survival rate after transplanting.

Smearing the stem with oils and greases proved deleterious.

Two further trials were conducted using proprietary preparations to stimulate the rooting and establishment of large stumped buddings, and of budded stumps transplanted during unfavourable conditions. In no case did the synthetic growth substance preparations have any marked beneficial effect on the percentage of successes.

The crown budding experiment to test the effect of the crown on the yield of the middle piece of double budded trees continue in progress. The first budding at the normal height was carried out in March 1952.

The four clones represented in this trial area (16.4 acres), BD 5, LCB 870, Tjir 1 and a *Hevea spruceana* clone, differ in their vigour, susceptibility to leaf diseases, yield and latex properties. Each main plot has been split into four subplots, and each clone has been topworked or crown budded at 6 ft from the union with buds of the same four clones. The first round of top budding was made in December 1953. Due to the low successes, especially where BD 5 was the panel clone used as stock in this bud grafting operation, two further budding rounds were made in January and March 1954.

The BD 5 trees were almost constantly defoliated by *Glocosporium* attack. The bark would not strip easily, indicating low cambial activity and the percentage of budding failures was high. Microscopic examination of stem sections confirmed that the cambium was sluggish, and the anatomy of the differentiating tissues was similar to that of normal trees during wintering. This emphasises the necessity of protecting material susceptible to leaf disease from infection and consequent defoliation and suppression of cambial activity until top working has been effected. This is recognised in Latin American field practice.

The percentage success for the whole trial was 66 per cent in the first round. The failures were budded again and gave 43 per cent in the second round, but during that time 20 per cent of the original successes were lost, thus after the second round the situation was little improved. The success of the third round was 39 per cent, but 8 per cent of the previous successes had since died. Thus the overall success after three rounds was 75 per cent.

Unfortunately during the latter rounds of budding in the case of the least successful combination, *Hevea spruceana* on BD 5, more of the earlier successes were lost than new successes obtained. Cutting back was delayed until early May when all the attempts at budding had been made in order to obtain uniformity of crown age in this experiment. But in commercial practice in would be better to cut back top budding successes as soon as possible, especially in the case of difficult combinations.

The successful crown buddings were cut back in May at 8 ft (24 inches above the height of budding) and the stems were ring barked to the wood above the budding. The young shoots were tied back to the remaining portion of the stem as a protection against wind damage. Nevertheless before the new union had hardened off 4.5 per cent of the bud shoots were broken off by wind. These losses amounted to 11.5 per cent where LCB 870 was the crown. Twenty successful crown buddings were transplanted after cutting back. No special treatment was given. Eleven survived and the crown buds have since grown out.

The complete growth and yield data up to December 1952 from a density of planting experiment in Field 14C & D on the R.R.I. Experiment Station have been analysed statistically and the results are being prepared for publication.

Tree Poisoning

Investigations of tree poisons and of methods of application carried out in the Botanical Division of this Institute in 1936 resulted in the recommendation of sodium arsenite applied as a 5 lb per gallon solution to a frill girdle cut into the wood of the main stem at a convenient height from the ground. This method, was later superseded in a large measure by the cheaper 'ring barking' method in which the solution of sodium arsenite, thickened by the addition of tapioca starch, is applied directly on to the wood after removal of a ring of bark about eight inches wide.

Sodium arsenite is, however, a dangerous poison to humans and animals and investigations have been continued in the Botanical Division with the object of finding an effective tree poison which is less dangerous to handle and which could be used on estate or smallholdings unable to comply with the requirements of the Poisons (Sodium Arsenite) Ordinance 1949.

The early promise obtained with formulations of 2,4,5-trichlorophenoxy acetic acid (2,4,5-T) and reported in the *Journal of the Rubber Research Institute of Malaya* 14(1953) 182, has been realised and the normal butyl ester of 2,4,5-T as a 5 per cent acid equivalent solution in gas oil (e.g. Shell 'Diesoline' or Standard Vacuum 'Mobildiesel') has been shown to be an effective tree poison when painted or sprayed on to the bark all round the base of the tree from ground level to a height of about fifteen inches. The trees are usually leafless and dead within three to four months after treatment.

The following results were obtained in experiments on tree poisoning carried out during the year. A small scale trial was carried out on a smallholding using the normal butyl ester of 2,4,5-T at 5 per cent and 10 per cent concentrations in diesel oil, which in a previous trial had given 100 per cent of kills when applied either by the frill girdling or the ring barking method. The 2,4,5-T was applied with a brush (a) to a 15 inch band of the main stem at the base of the tree and (b) to a ten inch wide ring barked portion of the stem at about 4 feet from the ground.

The latest observations made five months after treatment showed for the 5 per cent concentration 100 per cent kills in method (a) and 91 per cent in method (b). A 10 per cent concentration of 2,4,5-T in diesel oil gave 100 per cent of kills by both methods of application. A third method of application of the 2,4,5-T in diesel oil to a ten-inch band of bark on the tapping panel gave inconclusive results.

Treatment with a 2 per cent solution of 2,4,5-T in diesel oil to a 15-inch band of the main stem at the base of the tree in another experiment on old trees with an average girth of 30 inches at 50 inches from the ground gave 50 per cent of kills after three months and 79 per cent after eight months. The experiment was repeated on larger trees, averaging 54 inches in girth, on the R.R.I. Experiment Station with the following results nine months after the treatments were applied with a brush to the main stem for a distance of 15 inches from the ground.

	Sodium arsenite		*2,4-D in diesel oil*		*2,4,5-T in diesel oil*	
	5 lb/gal	*10 lb/gal*	*5%*	*2%*	*5%*	*10%*
Percentage of trees dead	0	0	67	75	94	100
Percentage of trees still alive	100	100	33	25	6	0

The best results have been obtained with 2,4,5-T at concentrations of 5 and 10 per cent. The trees showed an increased yield after treatment with 2,4-D and 2,4,5-T. The experiments will be continued with the object of achieving a slower rate of death of the trees and consequently in an extension of the period of stimulated yield.

The total cost of poisoning trees with the 5 per cent solution of 2,4,5-T in diesel oil is at present prices about 17 cents per tree. The cost may be reduced by spraying the chemical on to the bark and possibly by the use of a cheaper oil carrier such as fuel oil.

This method of poisoning trees for replanting has been adopted by the Rubber Industry (Replanting) Board for use on smallholdings where, owing to inability to comply with regulations governing the use of sodium arsenite, this chemical cannot be used.

Budwood despatches to countries contributing to the Malaya Rubber Fund—Budwood despatched to Nigeria in March consisted of two yards each of clones RRIM 600 to 630, RRIM 509 and AVROS 157 and in October two yards each of clones RRIM 605, 607, 610, 627 and 630. To British North Borneo budwood despatches in January consisted of 5 yards each of clones 603, 612 and 3 yards of clone RRIM 610 and in April of 5 yards of clone RRIM 501.

TAPPING

With the present tendency to increase the height of opening of tapping panels numerous enquiries have been received regarding differences in girth and bark thickness at various heights on young budded and seedling trees. As most of our prewar records on this important subject have been lost during the period of enemy occupation, new measurements have been taken during the year on a number of estates situated on both inland and coastal soils on buddings of clones Tjir 1, Gl 1 and RRIM 501, budded in 1947 to 1949, and on clonal seedlings planted in 1947.

The results are summarised as follows:

	Girth (in.) at height of			*Bark thickness (mm) at height of*		
	20 in.	40 in.	60 in.	20 in.	40 in.	60 in.
Mixed clones	24.6	23.4	22.8	7.2	7.8	7.2
Clonal seedlings	31.4	26.4	24.9	8.6	7.1	7.8

It is noted that in budded trees the difference in girth at 40 inches and at 60 inches is only just above half an inch while on seedling trees it may be as much as 1½ inches. There is no difference in bark thickness at these two heights. In seedling trees the difference in girth at 20 inches and at 40 inches is about 5 inches while in buddings it is only 1¼ inches. The difference in bark thickness at these two levels is about ¾ inch in clonal seedlings and nil in budded trees.

Yield recording continued during the year in 13 tapping experiments; 7 on the R.R.I. Experiment Station, 5 on estates and 1 on a smallholding of the Smallholders' Advisory Service.

Our oldest full circumference tapping experiment on budded trees which had been carried out on buddings of nine clones in the plot boundary rows of a clones trial since July 1937 was discontinued at the end of April 1953. The results over the full period of yield recording are given in the *Report* for 1953.

An experiment on the stimulation of yield of bark of second renewal was set up in this field during the year.

The small scale experiment with full circumference systems on unselected seedling trees planted in 1928 continued in recording. The results to date show that the double cut periodic system with alternate daily tapping on two half spiral cuts, one on each side of the tree and 20 inches higher than the other and in which periods of rest follow equal periods of tapping at 200 per cent intensity, (2S/2.d/2.3m/6. 100%), has not maintained the small advantage in yield (8 per cent) shown for the period 1935 to 1941 over the control system of continuous alternate daily tapping on a half spiral cut (S/2.d/2.100%); the average yield over the post-war period 1947 —1954 showing a decrease of 4 per cent relative to the control.

Results over the corresponding periods for the double four system (2S/2.d/4.100%) show yield increases of 20 per cent and 12 per cent and for the full spiral fourth daily system (S/1.d/4.100%) of 43 per cent and 13 per cent respectively, over the control system. All three full circumference systems have had a depressing effect on girth, that of the full spiral fourth daily system being equivalent to 2½ inches during the period 1938 to 1953.

The results for the first seven years of continuous tapping in an experiment set up on mixed buddings of sixteen clones, budded in May 1932, to compare the half circumference alternate daily system (S/2.d/2.100%) and the full spiral fourth daily system (S/1.d/4.100%) show that under the conditions of the experiment on mature buddings of 16 clones full spiral fourth daily tapping has no advantage over half spiral alternate daily tapping. The indications are that the saving in tapping costs resulting from the former system may be offset by the relatively high proportion of cup lump and scrap and the reduced girth increment associated with full circumference tapping.

Results for the first five years of tapping in an experiment on mixed buddings of five clones, budded in 1932, to compare three full spiral systems of 100 per cent intensity and the S/2.d/2.100% system show that the best yields have been obtained in the continuous full spiral fourth daily system (S/1.d/4.100%) but the percentage of lower grades is also higher in this system.

The full spiral third daily system with nine months' tapping and three months' out of twelve (S/1.d/3.9m/12.100%) has yielded more than the control half spiral alternate daily system (S/2.d/2.100%), with no increase in brown bast incidence. The dry rubber content in this system is about one per cent unit less than that of the control system. The full spiral alternate daily system in which periods of rest follow equal periods of tapping (two months) at 200% intensity (S/1.d/2.2m/4. 100%) is the lowest yielding of the three full spiral systems and has the lowest percentage of lower grades.

A comparison of four periodic full spiral fourth daily systems (ABC and ABCD) of 67 per cent and 75 per cent relative intensity and the continuous full spiral fourth daily system on mature buddings of seven clones budded in 1931 has shown over a period of six years large differences in the response of the clones; clone Tjir 16 showing the most favourable response AVROS 50 the least. The systems with eight months' tapping followed by four months' rest (S/1.d/4.8m/12.67%) and with twelve months' tapping followed by six months' rest (S/1.d/4.12m/18.67%) have given approximately the same yields, 75 per cent of that of the control system S/1.d/4.100%, showing no advantage in extending the period of tapping and of rest.

The systems of 75 per cent relative intensity with twelve months' tapping followed by four months' rest (S/1.d/4.12m/16) and with eighteen months' tapping followed by six months' rest (S/1.d/4.18m/24) have likewise given much the same yields, 80 per cent of that of the control system S/1.d/4.100% over the full period of five years. All four periodic systems have yielded slightly in excess of their expected yields, their effect on growth and that of the continuous full spiral fourth daily system will be ascertained when the experiment has been in progress for a longer period.

A small scale experiment carried out on trees of the same clones and of the same age as in the preceding experiment to study the effect on yield and growth of extending the interval between tappings on a full spiral cut from four days to five days (S/1.d/5.80%) and to six days (S/1.d/6.67%) has shown over a period of six years yields in excess of the tapping intensity. The yields of the systems of 80 per cent and 67 per cent intensity show a slow but steady increase from year to year relative to the fourth daily system of 100 per cent intensity.

A small scale trial on a mixed stand of clones Tjir 1 and Pil B84, budded in 1939/1940, compares the standard system of half spiral alternate daily tapping (S2.d/2.100%) with a system of daily tapping on a third spiral cut for about twentyfour days out of thirty (S/3.d/1.24d/30.107%) which approximates to a system commonly used on smallholdings. The results over a period of six years show an advantage in yield of the smallholders' system of 12 per cent and no difference in girth between the two systems. Bark consumption during the full period has, however, been 1.5 inches per month on the smallholders' system compared with 1.0 inch per month in S/2.d/2. 100% system.

As a means of reducing the incidence of brown bast in clonal seedlings an experiment has been set up on 20 years old clonal seedlings on the R.R.I. Experiment Station comparing half circumference and third circumference systems of 67 per cent intensity and half circumference change-over systems of 100 per cent intensity.

High tapping or ladder tapping—This form of tapping is being tried on budded trees of nine clones planted in 1929 in a clones trial on the R.R.I. Experiment Station and in which a yield decline of 30 per cent was recorded during the first year of tapping on bark of second renewal.

The clone trial was originally laid out in a randomised block design with four replications each of nine clones. Each plot consists of nine rows of nine trees and for the purpose of this high tapping experiment four rows are tapped alternate daily on the existing low half spiral cuts, (S/2.d/2.100%), which at the beginning of the experiment was about 30 inches above the union, four rows are tapped alternate daily on a new half circumference V-cut (V/2.d/2,100%) opened at 90 inches above the union and the centre row is tapped alternate daily on both low and high half circumference cuts (2C/2.d/2.200%), the cuts being on opposite sides of the tree and tapped on the same day.

Yield recording is done by cup coagulation on two tapping days in each month.

The yields for the period June to December 1954, expressed as a percentage of yields recorded on the existing half spiral cut in the month of May in the three sub plots of each plot, show marked differences in the response of the clones to high tapping on virgin bark; clones Pil B84, PB 186, Pil A44 and Tjir 1 showing increases of 201, 154, 121 and 78 per cent respectively while clones AVROS 50, AVROS 152

and PB 23 show little or no increase. Clones BD 5 and AVROS 49 show small increases of 49 and 26 per cent respectively. The mean increase for all clones amounted to 72 per cent.

During the same period clones Pil B84, BD 5 and Pil A44 tapped on low cuts show yield increases of 30 per cent, 23 per cent and 11 per cent respectively over the pre-treatment yields.

The yield of trees tapped on both low and high cuts (2C/2.d/2.200%) would suggest that the yields from the low cuts are only slightly affected by the tapping on high cuts on the opposite side and separated by a vertical distance of 60 inches from the low cuts. Further results will show for how long the trees in the centre rows of each plot can withstand continuous tapping at 200 per cent intensity.

Properties of latex from high and low cuts—The concentrate prepared from the latex of each clone obtained from the high cuts and from the low cuts has been tested for mechanical stability in the Chemical Division and it was found that, with the exception of clones AVROS 50, PB 186 and Pil B84, the mechanical stability of the latex concentrate after the first month was lower for the high-cut latex. This was especially so of clone Tjir 1 and, to a lesser extent, of clones Pil A44 and AVROS 152. After standing for three months, however, the mechanical stability of the latex concentrate of all nine clones had shown a large increase and had reached a value well above the minimum value of 475 seconds specified by the American Society for Testing Materials.

Tapping-cum-manuring—An experiment has been designed to be set up on a collaborating estate to test three tapping systems of different intensities, namely S/2.d/3.67%, S/2.d/2.100% and 2S/2.d/3.133% with four levels of manuring. There will be four replications of each tapping system, each replication to include 3 main plots (tappings systems) and each main plot to include 4 sub-plots (manuring treatments), giving a total of 12 main plots or 48 sub-plots. The size of the main plots has been made to correspond to a tapping task which will be 540 trees on the S/1.d/3.67% and S/2.d/2.100% systems and 270 trees on the 2S/2.d/3.133% system.

Slaughter tapping—In an earlier experiment, described in the annual *Report* for 1953, it was shown that a slaughter tapping system of moderate intensity combined with the use of a yield stimulant gave yields of the same order as those of higher intensity slaughter tapping systems with no yield stimulation, thus resulting in a saving of tapping costs.

Another slaughter tapping experiment on moderately yielding, well grown unselected seedling trees planted in 1912 gave the following results over a period of one year. System 3V/2.d/4.150% in which tapping was fourth daily, downwards on one half circumference V cut in renewed bark and and upwards on two half circumference V cuts opened on opposite sides of the tree in virgin bark just above the highest level of the old panels, gave an increase of 167 per cent which was further increased to 200 per cent by treatment with yield stimulant.

System 4V/2.d/4.200% in which two half circumference V cuts are tapped downwards in renewed bark and two other half circumference V cuts are tapped upwards in virgin bark, fourth daily, gave no further yield increases with or without treatment with yield stimulant, showing no additional advantage of tapping thin renewing bark on the opposite basal panel.

System 3V/2.d/2.300% in which three half circumference V cuts are tapped alternate daily, two cuts tapped upwards in virgin bark and one cut tapped downwards in renewed bark, did not result in greatly increased yields relative to the other systems.

The yield increase brought about by the yield stimulant in the most intensive system used (300 per cent tapping intensity) is only about 18 per cent and treatment with yield stimulant may not be economic when combined with high intensity tapping systems.

The most economic system for the period of one year was the 150 per cent intensity system with upward tapping on a full circumference and downward tapping on a half circumference every fourth day (3V/2.d/4.150%), combined with the use of the yield stimulant, which gave almost the same yields — about three times that of the half circumference alternate daily system — as the 300 per cent intensity alternate daily system (3V/2.d/2.300%) with a considerable saving in tapping costs.

There is some evidence that a yield increase of the same order would have been obtained by treating only the high (upward tapped) cuts on virgin bark with the yield stimulant. This would result in a substantial saving in labour costs, as scraping of poor corrugated renewed bark is slow and laborious, and in a saving in the expenditure on the yield stimulant.

The observation made in the earlier experiment to the effect that a moderate intensity slaughter tapping system combined with the application of a yield stimulant at four-monthly intervals may be the most economic slaughter tapping system is supported by the results of this experiment.

Tapping Experiments on Estates

A tapping experiment comparing full circumference systems of 100 per cent intensity and the half spiral alternate daily system was set up in 1947/1948 in a standard clones trial on three estates.

On one estate, situated on coastal clay soil with peat, the results over a period of seven years show for clones Pil B84, PB 86, PB 186, Pil D65 and BD 5 budded in 1938, a slight advantage of the full spiral fourth daily system (S/1.d/4.100%) and for clone Gl 1 a loss of yield of 12 per cent. In the seventh year of this experiment the full spiral fouth daily system gave only 80 per cent of the yield of the half spiral alternate daily system, the yield of clone Gl 1 being only 63 per cent of that on the S/2.d/2.100% system. The average girth in March 1954 is 1.1 inches less in the full spiral fourth daily system and the brown bast incidence is approximately the same in the two systems.

On another estate situated on coastal soil three tapping systems, namely the full spiral fourth daily system (S/1.d/4.100%), the double-four system (2S/2.d/4.100%) and the half spiral alternate daily system (S/2.d/2.100%) are being compared on buddings of the same six clones represented in the previous experiment. The results over the first six years show a loss of 8 per cent on the S/1.d/4.100% system and one of 4 per cent on the 2S/2.d/4.100% system. In this experiment clone Gl 1 gave the poorest response to full circumference systems and is tapped at a reduced intensity owing to the high incidence of brown bast in the 100 per cent intensity systems. Differences in mean girth and in brown bast incidence are small in the three tapping systems.

The third estate situated on an inland soil provides for a straight comparison of the S/1.d/4.100% and the S/2.d/2.100% systems on trees of clones Tjir 1 and 16, Pil B84 and D65 and PB 86 budded in 1939. The results for the first seven years of tapping show an average loss of yield for all clones of 20 per cent in the S/1.d/4.100% system; clone Tjir 1 being the least affected (loss of 7 per cent) and clones Tjir 16 and Pil B84 the most affected (loss of 22 per cent).

An experiment was set up in April 1950 in an area of 30 acres of clone Tjir 1 budded in 1941 on a collaborating estate to compare the effect on yield, growth and brown bast incidence of periodic change-over of tapping panels in the half spiral alternate daily system and different periods of tapping and of rest in full spiral third daily and fourth daily systems.

The tapping systems consist of one continuous and two periodic half spiral alternate daily systems of 100 per cent intensity, three full spiral systems of 100 per cent intensity, three full spiral fourth daily periodic systems of 75 per cent intensity, three full spiral fourth daily periodic systems of 67 per cent intensity and three full spiral third daily periodic systems of 100 per cent intensity. The experiment is of a randomised block design with four replications of each tapping treatment.

The results for the first four years of tapping show a small advantage in yield of the continuous full spiral fourth daily system (S/1.d/4.100%) over the control system of half spiral alternate daily tapping (S/2.d/2.100%) and the difference in the yield of the two systems is significant at the 5 per cent level. The change-over half spiral alternate daily systems have yielded slightly less than the control system.

The periodic full spiral fourth daily systems of 75 per cent and 67 per cent intensity and third daily systems of 100 per cent intensity have given relative yields slightly in excess of their tapping intensity.

There has been no increased incidence of brown bast in the periodic full spiral third daily systems where for continuous periods varying from 9, 12 to 15 months before rest, the trees are tapped at 133 per cent intensity, or in any other system except the periodic full spiral alternate daily system (S/1.d/2.2m/4.100%) in which periods of rest of two months follow equal periods of tapping at 200 per cent intensity. In the latter system the percentage incidence of dry trees was 4.1 compared with 2.8 in the control S/2.d/2.100% system. The rate of bark renewal was higher in the full spiral fourth daily systems, the percentage renewal after four years being 84 per cent compared with 73 per cent in the S/2.d/2.100% system.

Bark consumption has been less on the full spiral third daily periodic systems of 100 per cent intensity than on the continuous full spiral fourth daily system.

There has been no adverse effect of the continuous full spiral fourth daily system and of the periodic full spiral third daily systems on growth over the first four years of the experiment. The best growth is recorded in the periodic full spiral fourth daily system of 67 per cent intensity, the beneficial effect increasing with the duration of the period of rest, and the poorest growth is found in the full spiral alternate daily system with two months tapping out of four (S/1.d/2.2m/4.100%).

The relative tapping cost in the full spiral fourth daily system is 70 per cent of that of the S/2.d/2.100% system and 68 per cent in the periodic full spiral fourth daily and third daily systems. In the change-over half spiral alternate daily systems the relative tapping cost is 104 per cent of that of the control system.

Another experiment was set up on a collaborating estate in October 1953 in a replanting of clone Gl 1 budded in 1947 with the object of comparing the effect of two change-over half spiral alternate daily systems with six months' and twelve months' tapping on each of two opposite panels, (S/2.d/2.2x6m/12.100% and S/2.d/2.2x12m/24.100%) of a change-over half spiral third daily system with twelve months' tapping on each of two opposite panels (S/2.d/3.2x12m/24.67%) and of the continuous half spiral third daily system (S/2.d/3.67%). The cuts in the change over systems are separated by a vertical distance of 24 inches. The first change-over of tapping cuts took place in the S/2.d/2.2x6m/12.100% on 1 April 1954.

In the first year of tapping the relative yields of the 67 per cent systems are in excess of the tapping intensity, averaging 76 per cent and there are no significant differences in the mean yields of the two 100 per cent intensity or in those of the two 67 per cent intensity systems. No differences in the mean girth of the trees in the different tapping treatments have been detected at the end of the first year of tapping.

PHYSIOLOGY

Fundamental Research on Latex Physiology

All carbon compounds within the plant must ultimately be derived from the products of photosynthesis although the precise details of intermediate stages may be still in dispute. In rubber producing plants the nature of the substrate for rubber synthesis has not been established experimentally. It is considered important, therefore, to verify with hevea the mechanism of rubber synthesis suggested by BONNER and ARREGUIN (Arch. Biochem. 21(1949)109 who, working with the guayule plant (*Parthenium argentatum*), demonstrated that acetate, acetone and B-methylcrotonate were effective in promoting rubber formation.

Baptist and Riches (unpublished report 1949) in one of the first attempts made to study the hydrocarbon metabolism of hevea seedlings found appreciably larger amounts of rubber hydrocarbon in the tissues of etiolated hevea seedlings which had been fed with inorganic culture solutions enriched with acetate, the increased rubber content being located largely in the fraction soluble in cold benzene (low molecular weight rubber). For an understanding of the mechanism of mobilisation of reserves information is required both as to the enzymes present and of the substrates upon which they act.

Growth responses and histological changes resulting from application of pastes containing synthetic growth substances must depend on a supply of metabolites derived either from insoluble reserves in neighbouring cells or from the main supply passing down the phloem. If these metabolites include precursors concerned in the synthesis of macromolecules the use of synthetic growth substances may throw light on the mechanism of rubber formation. In addition to this approach feeding experiments are also in progress with etiolated young hevea seedlings.

The programme for the first quarter of the year was upset by the fire on the night of 13 January in the air-conditioned section of the new laboratories on the R.R.I. Experiment Station and by the lack of electricity until 10 February.

The culture in nutrient media of hevea cellus tissue from excised segments of stem tissue was continued throughout the second half of the year as a secondary experiment; there being little scope for this experimental technique in the study of the physiology of rubber formation by the addition of metabolites owing to the slow rate of growth and frequent contamination. The addition of 2.5 mg/litre of cysteine hydrochloride to

the culture medium gave an increase in the number of stem segments forming callus tissue. All attempts at sub-culturing these callus growths failed, mainly through contamination. Attempts to culture tap roots, adventitious roots and hypocotyls in liquid medium failed entirely. In a semi solid agar medium several tap roots continued to grow but the growth became weaker with the passage of time; there was no appreciable thickening of the older tissues. This type of growth suggests either an exhaustion of the medium or a deficiency of growth hormones which become more pronounced as the medium is used up. Excised roots and seedling roots of hevea were found to give unhealthy growth in the inorganic culture medium found suitable for other dicotyledons. A quarter strength of the normal inorganic content gave far better and healthier growth.

So far attempts to grow in culture buds from surface sterilised budwood have failed through contamination but experiments with various surface sterilising agents are continuing.

It has been confirmed that 2,4-D stimulates peroxidase activity in the roots of hevea seedlings. Increased activity was detected in tissue extracts from all 2,4-D treatments. The suppression of catalase activity in the leaves was also confirmed. Ascorbic acid oxidase, an enzyme linked with 2,4-D activity in other plants, has not been detected in hevea tissue.

Bark samples of 3 years old buddings of clone Tjir 1 treated with 2,4-D and 2,4,5-T at about two feet from the ground were taken at about six inches above the place of application and the enzymic activity investigated.

It was considered, that if the well established yield increases caused by treatment of the bark with these synthetic growth substances are due to increased biosynthesis of rubber, some indication of the enzymes involved might be provided by the levels of activity before and after treatment.

It was found that both 2,4-D and 2,4,5-T cause an increase in peroxidase, polyphenol oxidase and invertase activity. No phosphorylase activity was detected and since from other work it appeared that these synthetic growth substances did not appreciably affect the biosynthesis of rubber this work was discontinued.

By using discs of young hevea leaves floating in solutions of 2,4-D at concentrations of 50, 100, 200, 300, 400 and 500 p.p.m. for 3 hours it has been shown that 2,4-D increases water uptake in this tissue and that water uptake increases with 2,4-D concentration. While the method of using leaf discs is not sufficiently accurate to give the critical concentration at which 2,4-D stimulates maximum water uptake, it does, however, demonstrate the relation between the concentration of 2,4-D and water absorption. With discs from the bark of 18-month-old seedlings it was not possible to establish any such relation.

Five months old hevea seedlings sprayed with 2,4-D solution at concentrations of 250 or 500 p.p.m. showed after one week a severe wrinkle of the upper leaves which after ten days showed symptoms of severe sun scorch. Solutions of 50 and 100 p.p.m. of 2,4-D were not toxic to the young seedlings. 2,4-D and 2,4,5-T at a concentration of 1 per cent acid equivalent in palm oil thickened with petrolatum applied to the stem of 16 months old hevea seedlings proved fatal to the young plants.

Recent preliminary work with etiolated young hevea seedlings using the bromination method for the estimation of rubber hydrocarbon has not shown in acetate-fed

plants the clear increase in rubber accumulation shown by the plants fed with inorganic solution enriched with M/1000 sodium acetate plus acetone, and adjusted to pH 6.0, and with M/1000 acetone.

An attempt is being made to establish a relation between the auxin content of the bark of hevea and yield. For this purpose the Avena coleoptile extension assay method of Bentley and Housely has been tried out and a straight line obtained for the extensions over the range of concentrations of 3, 6, 12 and 24μ per litre of indolyl acetic acid.

Physiology of Latex Flow in response to Tapping

The effect of tapping, before and after the application of a yield stimulant, on the dilution of the latex in the latex vessels at various distances above and below the tapping cut has been investigated. A slight modification of Ferrand's method for estimating the total solids in situ was used and the experiment was carried out on two buddings of clone Tjir 1 of approximately the same girth and yielding capacity.

Sampling was done at distances of five feet and two feet above the tapping panel and at two feet and three feet below the tapping cut. Latex samples were also taken on the rootstock and on an exposed lateral root at a distance of 4 feet from the taproot.

Very marked dilution effects due to stimulant treatment were noted at all sampling points, especially in the root, where no effect was observed on normal tapping.

The results of this experiment suggest that the area of bark which contributes to the latex flow becomes extended after treatment with yield stimulant and this may to some extent explain the low brown bast incidence in our yield stimulation experiments.

Stimulation of Yield and Bark Renewal

In an experiment on 24 years old trees of clone AVROS 50 a substantial increase in yield (about 60 per cent) has been obtained over a period of eighteen months as a result of monthly applications above the tapping cut, to the width of bark excised during the previous month, of 'Stimulex' and of a 1 per cent acid equivalent concentration of the normal butyl ester of 2,4-D in palm oil or in Standard Vacuum Product 2295C. Large yield increases were also obtained with a similar concentration of 2,4,5-T in palm oil.

The rate of bark renewal was increased by the application of 2,4-D at concentrations of 0.1 per cent and 1 per cent in palm oil or petrolatum. The 2,4-D had an outstanding stimulating effect on the thickness of the renewed bark, the mean increase in bark thickness of the control trees during the first experimental year being 1.2 mm compared with 3.3 mm for those treatments which contained a 1 per cent concentration of 2,4-D. The increase in bark thickness is shown by anatomical examination of bark sections to be confined to the outer non latex-bearing portion of the bark and it has not measurably affected the number of rows of latex vessels.

A full account on the work of yield stimulation has been given in a series of three papers on 'Stimulation of Yield in *Hevea Brasiliensis*'.

The main findings from three long term experiments in progress on the R.R.I. Experiment Station may be summarised as follows:

The 1 per cent acid equivalent of 2,4,5-T in a mixture of palm oil and petrolatum and Stimulex are the most effective yield stimulating mixtures used.

There is a decreasing response of yield with successive half-yearly applications of yield stimulants to trees tapped on the S/2.d/2.100% system.

No increase in brown bast incidence has been observed after six successive half-yearly applications of yield stimulants to 20 years old clonal seedlings.

Application of a yield stimulant to a three inch strip of bark below the tapping cut does not only increase the yield but also the thickness of the renewed bark above the cut.

In an experiment carried out on buddings of nine clones planted in 1929 and tapped on bark of second renewal, a good response was given by clones PB 23, BD 5, Pil A44 and AVROS 50 whereas clones PB 186, Tjir 1 and Pil B84, (which incidentally gave the largest yield increases on ladder tapping), reacted disappointingly to two successive half-yearly applications of yield stimulant below the cut.

Treatment of three-inch wide strips of bark below both half spiral cuts of trees tapped on the double-four (2S/2.d/4.100%) system leads to high peak yields, but the yield drops below the level of that of the control in subsequent months. It is suggested that treatment on a three inch strip of bark below a full spiral cut may show a similar reaction.

It would appear that high yield increases can also be obtained by monthly treatment of the freshly tapped bark immediately above the tapping cut. This treatment also results in highly significant increases in the thickness of the renewed bark, but the number of latex vessels remains unaffected.

In a large-scale experiment carried out on unselected seedlings it has been demonstrated that the properties of the latex concentrate and of dry rubber obtained from trees treated with yield stimulant are not affected, although the d.r.c. of the field latex is slightly reduced and the copper content is very slightly increased.

The properties of latex concentrate and of dry rubber are likewise not affected by injection of copper compounds into rubber trees and a marked increase in yield was obtained by injection of 10 grams of copper sulphate or copper nitrate.

Four different methods of application of a yield stimulant (2,4,5-T as at a concentration of 1 per cent acid equivalent in a mixture of palm oil and petrolatum) are being compared in an experiment carried out on a mixed stand of buddings of clones AVROS 50 and Pil D65 budded in 1931. The trees are tapped alternate daily on a half spiral cut on weak first renewal bark.

The results over a period of three months after treatment show yield increases of:

38 per cent for a single application to a 3-inch strip of scraped bark below the cut.

21 per cent for a single application to a 3-inch strip of unscraped bark below the cut.

4 per cent for a single application to a 3-inch strip of scraped bark 5 feet above the panel.

53 per cent for a monthly application above the cut to bark excised the previous month.

The additional effect on yield of a light scraping of the bark is clearly shown in this experiment, but the yield increase of the unscraped trees is still very satisfactory. The yield curve of the first two treatments have shown a peak initial rise followed by a fall whereas the yield curve of the fourth has shown a more gradual rise to a level

which for the present is being sustained. The suggestion from a previous small-scale experiment that the third treatment might be promising has not been confirmed.

ECOLOGY

An ecological survey of one acre of secondary jungle, part of an area which was cleared during the year as an extension of the R.R.I. Experiment Station, was made with the assistance of the Forest Botanist, Forest Research Institute, Federation of Malaya.

An area of 10 chains long and 1 chain wide was selected for the identification of all trees which are 12½ inches or more in girth. Within this area a 10 x ¼ chain transect was marked out for identification of the shrubs and this was done by dividing the transect into 40 quadrats of 25 x 25 links and recording all plants which measure 5 ft to 12½ inches in girth. A narrower strip 10 links wide was marked out down the centre of the original plot for a study of the ground flora. Along this strip 100 quadrats each measuring 10 x 10 links have been marked out and all plants below the height of 5 feet are being recorded.

To date over 3,097 plants have been recorded and of these 2,482 have been identified. The plants identified consist of 217 trees of 91 species and 29 families, of 1444 shrubs and 821 plants of 131 species of the ground flora. The identification and labelling of the stumps of trees for a study of the incidence and sources of root disease infection have been carried out for the Pathological Division. The effects of clearing and of rubber cultivation on the soil and vegetation will be followed.

One hundred and sixtyfive mounted specimens of indigenous cover plants have been added to the herbarium collection.

Assistance in the identification of natural covers in a trial of herbicides was given to the Soils Division. Eighteen to twentyfive plant species have been identified in each of 24 plots of 1/100 acre marked out for this weed control experiment.

ADVISORY

An appreciable increase in the number of letters received in the Division, representing an increase of 31 per cent over the previous year, occurred during 1954.

The general trend from 1952 onwards is shown in the following analysis

	1952	*1953*	*1954*
Letters received	1484	1802	2363
Visitors to Division	89	75	114
Visits to Estates	49	122	129
Samples received for examination or for identification	76	93	89

The number of letters despatched in reply to enquiries was 2230, of which 1116 were of a purely advisory nature.

In the review which follows the advisory correspondence has been analysed separately under the major sections of the research programme.

Breeding and Selection

Nine enquiries were concerned with the establishment of seed gardens. Rubber seeds samples were received from budded areas of sixteen estates for identification. The interest shown in high grade seed for use in replanting led to the preparation and publication in R.R.I. *Planters' Bulletin* of November 1954 of the article 'A Speculation in Seed'.

Propagation and Planting Technique

The largest number of enquiries have again been on the choice of planting material for use in replantings. The enquiries may be classified as follows:

Choice of planting material (clones & clonal seedlings)	551
Replanting enquiries	23
Supply & exchange of planting material	324

Sixtythree visits were paid to estates for the identification of clones in multiplication nurseries or in the field. Budwood of RRIM clones sold to estates for multiplication and use in replantings amounted to 2445 yards for RRIM 500 Series clones (43 estates) and to 3551 yards for RRIM 600 Series clones (129 estates).

Two papers 'R.R.I. 600 Series — Further Observations' and 'Planting Recommendations 1955-6' were prepared for publication in *Planters' Bulletin.*

Tapping

The enquiries on tapping numbered 137 of which 23 concerned high or ladder tapping for use on budded and seedling trees with thin bark of second or third renewal.

One hundred and two letters were received on the subject of commercial yields of buddings and clonal seedlings.

The articles 'Tapping Systems' and 'Tapping Prior to Replanting' submitted by the Botanical Division were published in *Planters' Bulletin* during the year.

Physiology

Interest in yield stimulants showed a considerable increase during the year, the number of enquiries reaching the high total of 204. Nineteen letters were received on the subject of drying up of trees through brown bast or unknown causes.

A leaflet 'Latex Yield Stimulation with 2,4,5-T" was issued for use in advisory correspondence..

A patent has been applied for on behalf of the Industry, during the year, for the use of 2,4,5-T and its esters and salts for the stimulation of yield in hevea. This yield stimulant prepared according to the R.R.I. formulation with the normal butyl ester of 2,4,5-T at a concentration of one per cent acid equivalent in a mixture of five parts of palm oil to three parts of petrolatum is now marketed in Malaya by two leading fertiliser firms.

Ecology

Routine advisory work under this section has consisted in the identification of sixty plants of twentyfive families received from estates. Seventyfive letters were received and sixtyeight letters were despatched in this connection.

Twentytwo pounds of fresh seed of the leguminous bush cover, *Flemingia congesta*, have been distributed among eleven estates. Germination tests were carried out on thirteen samples of leguminous cover crop seed during the year.

An article on 'Further Legume Covers' was prepared for publication in *Planters' Bulletin*. A note on the treatment of leguminous cover crop seed for the improvement of germination was incorporated in the article 'Establishing a Legume Cover' published in *Planters' Bulletin 14* of September 1954.

General Planting Enquiries

There were seventyone planting enquiries of a general nature of which twentysix concerned tree poisoning. A leaflet 'Poisoning of Rubber Trees with 2,4,5-T' was issued for use in correspondence and a note 'Poisoning of *Hevea* with 2,4,5-T' was prepared for publication in *Planters' Bulletin*.

Visits to estates were curtailed by the resignation of a Research Officer and by the absence on home leave for part of the year of two other Research Officers. The Head of Division visited seven estates in Kelantan during the month of June and four estates in Johore during the month of August.

Graduate Officers paid one hundred and twentynine visits to estates of which twenty-eight were made to give specific advice on problems arising on the estates.

Visitors

One hundred and fourteen visitors were received in the Division and thirty visitors were taken round the R.R.I. Experiment Station by members of the Division during the year.

E. D. C. Baptist
Head of Botanical Division

Pathological Division

The Head of the Division (Dr A. Newsam), Field Research Officer (Mr F. W. Hutchison), Pathologist (Mr R. N. Hilton), Assistant Pathologist (Mr K. P. John), and Assistant Entomologist (Mr B. S. Rao), were all on duty throughout the year. With the arrival of the Microbiologist, Mr R. A. Fox, the Division was at full strength in research officers. From the time of his appointment in January 1953 until he left to come to Malaya, Mr Fox received specialised training in microbiology in the United Kingdom. He joined the staff in Malaya on 2 March, 1954.

Dr Newsam and Mr Hilton attended as observers the Plant Protection Conference for the Southeast Asia and Pacific Region, convened by the Food and Agriculture Organisation of the United Nations. The conference took place in Singapore from 12 to 17 December.

Four lectures were given. Mr Hutchison delivered a lecture on root disease on three occasions: at Sungei Patani on 24 June to the local I.S.P. branch; on 8 October at Muar, and 29 November at Sitiawan, to the district Planters' Associations. On 10 December, Dr Newsam lectured to the district Planters' Association, Muar, on the recognition of pests.

Root disease was the subject concentrated on in preparing articles for *Planters' Bulletin*. A general article on the major diseases was published *Planters Bulletin 10*, followed by descriptions of the three minor root diseases in Nos *11, 14* and *15*. Further, a note on replanting a bad root disease area was prepared for the January 1955 issue. Other contributions were on mycorrhiza, powdery mildew, and part of the article on establishing a legume cover.

RESEARCH

DISEASES OF THE ROOT SYSTEM

Field experiments—The third round of inspection and treatment has been carried out in experiment G-50, where various stump poisoning procedures are being tested in a 1950 replanting on an inland soil. Differences between the poisoning methods are not strongly marked though there are indications that those methods which direct the poison more to the laterals rather than to the tap roots are more effective. With the better methods of poisoning, including the ring barking method which is advised for general practice, the incidence of disease is between a third and a quarter of that in the untreated control plots. The number of stumps that became sources of infection was in about the same ratio, as is to be expected.

The second round of inspection and treatment has been carried out in experiment CI-51, laid down in a 1951 replanting on a coastal alluvial soil. Here tree poisoning is being compared with stump poisoning treatments, while four degrees of eradication of diseased trees and three methods of control in the young stand are superimposed in the same area. The experiment is effectively more than a year behind G 50 because of the amount of supplying that has been necessary in establishing the replanting. All that can be said about the effect of preplanting eradication is that the sub-blocks where all the old trees were winched over have so far the highest incidence of disease. The cost of control is however less than elsewhere because there are no stumps to dig out, but this saving is small in relation to the initial cost. In the other sub-blocks where eradication was incomplete, the benefits expected from stump poisoning are not yet

clearly seen. Poisoning the standing trees, on the other hand, has resulted in a much lower incidence of disease in the young stand. Thus the cheapest method of clearing has so far resulted in the least root disease.

A conveniently placed area on an estate in Selangor has been made available for further observations on root disease in relation to replanting. It has been divided into two; in one half the diseased trees have been eradicated while in the other they have been located but left in place. All the standing trees have been felled and the stumps poisoned with sodium arsenite following the ring barking procedure. The method of control of root disease in the young stand will be the same throughout, seeking to economise on the eradication of sources of infection by removing (and burning) the lateral roots only, leaving the bole of the tree to decay in isolation. A creeping legume cover is being established. The experiment, which has been given the code number WC-54, should show the extent to which removing diseased trees will reduce the numbers of infections in the young stand, and cheapen the cost of control. To make it easier to interpret future observations the positions of all diseased stumps of the old stand, whether removed or left in place, have been permanently marked showing whether the infection was of white, red or brown root disease.

Rate of loss of infectivity of diseased root fragments—Observations on the survival of the three major root diseases in buried sections of infected root have been continued up to the fortieth month. The roots were placed at a depth of about twelve inches in soil that has since been kept clean weeded. Although the fungi are still found to be viable in the largest sections (80 or 160 cubic inches in volume originally) some variability in the result suggests that it will not be long before all will have died out.

Susceptibility of legume covers to rubber root diseases—Diseased rubber roots have been buried in plots of legume cover plants to observe their susceptibility to infection by the three major diseases. All sixteen covers tested were penetrated by *Fomes lignosus*; more than half by *F.noxius* and by *Ganoderma pseudoferreum*. Of the three commonly planted creepers—*Centrosema pubescens, Pueraria phaseoloides, Calopogonium mucunoides*—only the last was not infected by all three parasites. The failure to infect *Calopogonium* with *F. noxius* and *G. pseudoferreum* was attributed not to resistance but to poor inocula and the lack of suitably deep rooted plants.

Inoculation of rubber seedlings—Rubber seedlings have been grown in the air-conditioned glasshouse in five-gallon pots containing as inocula pieces of rubber root naturally infected with *F. lignosus*. There were eight pots, four containing natural soils of different types, four containing a coarse sand alone and with addition of organic matter of three kinds. A duplicate series was set up in the open because earlier experiments with potted plants in a glasshouse had given negative results. This time the plants in the glasshouse became infected, perhaps as a result of better light conditions made possible by the air-conditioning, perhaps because pots of larger size had been used. Growth of all the plants was satisfactory except in soil containing wood ash, where they remained stunted and chlorotic even after the hydrogen ion concentration had been reduced from its initially high level by adding sulphuric acid.

Many plants became infected without showing any signs above ground, the infection of the tap root which made contact with the inoculum having stopped short an inch or two below the soil surface leaving the lateral roots alive to support the plant. The only noticeable effect of soil type was the slight amount of infection in peat.

The inocula had been buried when the germinated seed was planted. The fungus soon became active, rhizomorphs extending through the soil and sometimes on to the inside wall of the pot, but when they were dug up at the end of six months their surfaces were black and hard with no sign of activity of the fungus. The rot inside was typical of *F. lignosus* except in a coastal clay soil which had become waterlogged.

The fungus was re-isolated from all but this last pot. The other inocula, split and reburied among the different soil types, became active again within a week. They were then successfully used to infect young trees growing in the nursery. This reversible suppression of activity of the parasite in buried root fragments is an observation of considerable interest.

Fundamental study of Fomes lignosus—A fundamental investigation of the root diseases was initiated with the arrival of the Microbiologist, whose appointment was made with this intention. *F. lignosus* has been chosen for a start on the problem as being the most destructive disease of rubber in Malaya. Microbiological activity in soil can exert a profound influence on root parasites in a variety of ways; it has been put forward to explain the effect of soil covers in reducing the incidence of disease in young rubber. Whether or not this view will be found to be justified, it is certain that a proper understanding of root disease problems must involve a general study of the soil microflora.

Field observations have shown that mycelium and rhizomorphs of *F. lignosus* move freely through the soil under a wide range of conditions, and that it is possible for rubber to become infected without being in direct contact with the source of infection. Vegetative growth of the fungus in an infected area is much more abundant where the soil carries a dense cover than where it is bare. This suggests that the fungus has a limited ability to live as a soil saprophyte, but it cannot maintain itself indefinitely in this way; thus it is restricted to the region of roots that it has parasitised.

The marked activity of *F. lignosus* in the upper levels of the soil, where the microflora is richest, does not encourage the view that antagonistic organisms are able to suppress its growth. In exploring the subject by the buried slide technique a marked absence of other fungi on the slides indeed suggests that *F. lignosus* may itself produce antibiotic substances. Rhizomorphs and mycelium in the soil are, however, invariably attacked by a variety of microorganisms, many of which have been isolated for study.

The formation and growth of rhizomorphs have been closely observed. Their bulk is made up mostly of slender thick walled cells, with broader thin walled cells restricted to the centre and the region of attachment to the surface on which the rhizomorph is growing. Growth is by progressive thickening of strands within a diffuse terminal fan of mycelium which, being highly susceptible to desiccation, explains why rhizomorphs cannot develop in exposed situations. *F. lignosus* does not extend above ground except in the shaded and moist conditions provided by leaf litter and other plant debris. If a dense mat of creeping cover has been allowed to grow right up to young trees, the fungus can grow profusely round the collar and penetrate it, killing the tree if it is not treated.

Investigations on growth in culture are a highly important aspect of the work on *F. lignosus*. Isolates from rubber and from other hosts do not all behave alike. While the significance of the differences remains to be determined, already it has been established that one culture supposed to have been *F. lignosus* is sufficiently different from all the others in culture that it cannot be the same. Isolated from the fork of a rubber tree (annual *Report* of the Pathological Division for 1949, page 11) it was taken as indicating a clear case of spore infection by *F. lignosus*, while its mistaken identity also implied that *F. lignosus* can parasitise the aerial parts of trees.

DISEASES OF THE TAPPING PANEL

Mouldy rot—The weather towards the end of the year was wet enough to allow a considerable build up of mouldy rot, making it possible to work off a long list of materials awaiting field trial. A new proprietary tar acid fungicide (Agrisol Vulcan Red) has been tested according to the standard procedure (annual *Report* of the Pathological Division for 1948, page 153) and found satisfactory in the concentration range 5 per

cent to 10 per cent. Small scale trials have been carried out with a number of water soluble materials that had shown promise in the laboratory. Paranitrophenol at 0.1 per cent gave good results as did dioctyl sodium sulphosuccinate (supplied by Long Ashton Research Station) at a concentration of 5 per cent. Neither has reached the stage of being recommended for use on plantations.

Certain non-aqueous materials including proprietary preparations and others made up locally were still under test at the end of the year. Some of them have already been found ineffective against the fungus or toxic to bark. Application of Standard Vacuum product 2295-C (which is harmless by itself) containing 5 per cent of a neutral tar oil fraction supplied by Long Ashton caused abnormal proliferation of the outer bark, giving rise to a pronounced bulge. The same effect had been seen at another site where an experiment was put down earlier in the year but abandoned when dry weather came. In general it is not easy to assess the effects of these waterproof dressings which obscure the mould growth even if they do not stop it. Most of the trees were visibly reinfected within three days of treatment, but an application every sixth day appeared to arrest the disease before any damage was done. The final assessment will depend on whether treated bark dies or survives.

Black stripe—A field trial on the control of black stripe was started at the end of last year as a check on the procedure advised. Observations were continued for six months, until tapping in the area (17-year-old PB 86) was changed over to a high panel. All the experimental trees were sprayed with 10 per cent Killigerm after every tapping. The infected bark and surface layers of the wood near the cut were excised from some trees, applying a dressing to the wound, to see if this drastic treatment assisted recovery. The remainder of the trees were not surgically treated. The experimental area was further divided, half the trees being left in tapping, half rested. Treatment was continued for two months, the first wet, the second coming into dry weather. Results were judged by activity of the fungus near the cut. There was little change while the wet weather lasted, but dry weather brought a rapid improvement. Visible infection of the rested trees disappeared at this time. The carefully conducted excision of diseased tissue had little or no effect. As a control measure it can be disregarded, though it may still be desirable to cut out the large burrs that form on the panel from old infections. It was further concluded that it is unnecessary to stop tapping trees infected with black stripe provided prophylactic spraying can be continued until the end of the wet season.

SECONDARY LEAF FALL

Specimens sent in response to the yearly circular have been examined in the usual way. The results for the main refoliation season are given in the accompanying Tables.

DISTRIBUTION OF REPORTED OUTBREAKS OF SECONDARY LEAF FALL

Territory	Outbreaks					
	Jan.	Feb.	Mar.	Apr.	May	*Totals*
Kedah	—	—	7	1	—	8
Penang & P. Wellesley	—	—	1	—	—	1
Perak	—	—	4	1	—	5
Selangor	—	—	5	8	1	14
Negri Sembilan	—	—	11	7	—	18
Malacca	—	—	2	—	—	2
Johore	2	—	27	7	—	36
Pahang	—	—	2	1	—	3
Kelantan	—	—	—	2	—	2
Totals	2	—	59	27	1	89

Oidium was the dominant parasite in the specimens received during March; the April specimens were more severely attacked by mites. Calculation of the 'mean intensity

Incidence of the Parasites Associated with Cases of Secondary Leaf Fall

Parasite	Percentage of cases in which present		unassociated	Mean intensity of attack
	Jan./Mar.	Apr./May		
Oidium	97	70	12.0	2.7
Hemitarsonemus	72	98	0.7	2.3
Gloeosporium	37	59	nil	2.1
Scirtothrips	47	58	nil	1.6

of attack', scored as was done with the 1953 data, gives values that are slightly higher, though the secondary leaf fall this year was reported to be rather less. One late outbreak reported in September from Kedah was due to *Gloeosporium*, *Oidium* being absent.

Dusting clone BD 5 with Vitospor ZX—Weekly dustings of 25-year-old trees of BD 5 on the Experiment Station were started in August, eight pounds of Vitospor ZX being applied to 170 trees in two adjacent rows. The object is to see whether *Gloeosporium* leaf fall, to which BD 5 is highly susceptible, can be controlled and the trees thereby enabled to retain a canopy normal for other clones.

OTHER LEAF DISEASES

Association of leaf diseases of seedlings with nutrients supplied—Pot culture experiments conducted by the Soils Division Plant Physiologist provided an opportunity to study the effects of nutrients on leaf diseases. In one experiment nitrogen was supplied at three levels of ammonium and of nitrate, combined with high and low calcium. Bird's eye spot appeared to increase with increasing nitrogen, but statistical analysis of scored data indicated that the effect was due to those plants receiving high nitrogen having a larger leaf surface exposed to infection. There was a clearer indication that *Colletotrichum* leaf disease was inversely related to nitrogen supplied, plants receiving low nitrogen being more susceptible. No effect due to calcium was detected.

PROTECTION AGAINST SOUTH AMERICAN LEAF BLIGHT

Aerial spraying trials—In response to the appeals published in *Planters' Bulletin*, two sites were offered for continued aerial spraying trails. Financial stringency necessitated postponing the work until 1955, but an aerial reconnaissance of the two areas has been made with the result that one has been found suitable and accepted. It consists of 200 acres of abandoned rubber where it will be possible to continue observations for a year at least. Previously the trials have had to be fitted into about four months between the end of wintering and the beginning of clearing.

The position with regard to spraying equipment is that rotary brush gear and a new pump, wind driven and of a capacity to feed the largest nozzles of the boom gear, arrived in time to be fitted and given a flying test at the end of 1953. The aircraft had to be modified slightly to take them. It has been estimated that the maximum rate of delivery with either equipment—boom and nozzle or rotary brush—is about 28 gallons a minute, equivalent to just over two gallons per acre when flying a one chain swathe at 90 m.p.h. A higher output is desired and can be obtained with the rotary brush gear by putting on extra brushes, which have accordingly been obtained.

Sampling papers were put down to recover the spray for droplet size measurement, but it appeared that high humidity had caused the stains to spread unduly, showing that the effect of moisture content of the paper on stain size must be investigated.

Surface sterilisation of budwood—Consignments of imported budwood have been dipped momentarily in alcoholic mercuric chloride to destroy pathogens that might be lodged on the surface. It has been found that immersion of brown budwood, with waxed ends, in 0.2 per cent mercuric chloride in 50 per cent methyl alcohol can safely be much more than momentary. Budding successes have been recorded following immersion times up to one hour, the budwood either being used straight away, or stored for a week before or after dipping. Storage was found to improve the chances of budding success. Complete success (ten out of ten) was achieved in one trial after dipping for an hour and storing the washed budwood for a week. It was incidentally observed that residual mercuric chloride on the bark of the bud patch killed the inner tissues of the overlying flap of bark during the two weeks before opening it up.

The tolerance of budwood to the alcoholic mercuric chloride dip suggests that it should be easy to cut sterile budslips. Such a technique if perfected would be the safest way of introducing planting material from other countries. So far no successful budding has been made from many such slips stored for ten days under a variety of conditions. Several have appeared uncontaminated and have been budded, but the buds have not taken.

STEM AND BRANCH DISEASES

Pink disease—Control measures have been studied on an estate in Selangor where a heavy outbreak of pink disease occurred on six-year-old trees of clone RRIM 501. The treatments tested were:
(*a*) spraying the early stages of infection and pruning advanced cases; (*b*) spraying every attacked tree; (*c*) spraying all trees. The trees were too large to be reached with extension lances fitted to knapsack sprayers except when ladders were used. Therefore for the prophylactic treatment a motor driven sprayer was brought into action to apply Bordeaux mixture, which does not scorch the leaves. The results did not justify the method. Fungicidal treatment of attacked trees achieved a fair degree of success in arresting the attack, Fylomac 90 at 0.5 per cent being as good as Bordeaux mixture but, like the tar acid fungicides, it burns the leaves that it falls on. Pruning increased the number of new infections; thus it appears dangerous rather than helpful.

Dieback—A *Colletotrichum* and a *Phyllosticta* have repeatedly been isolated from terminal dieback of branches, particularly of clone Gl 1 and certain clonal seedlings. Field observations suggested that the dieback was occasioned by drought conditions. Inoculation tests with young plants have produced minute lesions when a spore suspension of the *Colletotrichum* was sprayed on to leaves which were immediately wrapped in brown paper. Green shoots were inoculated with the *Phyllosticta* by cutting into them and tying on pieces of shoot carrying a culture of the fungus. Three of six twigs inoculated died six months afterwards, the plants having meanwhile been weakened by keeping the inoculated shoots leafless and by severing the lateral roots. The fungi were afterwards re-isolated from the dead tissues. This result, though not conclusive, accords with the field observations.

TERMITES

An advance in the control of termites has been made possible by the introduction of the new insecticides chlordane, aldrin and dieldrin. They have been used as emulsions in water, on the supposition that they would best penetrate undisturbed soil in this form. The three insecticides, and an emulsified form of benzene hexach-

loride, have been tried out for the protection of newly planted stumps in Field 52 on the Experiment Station, where a convenient opportunity arose towards the end of last year when four and half acres had to be replanted partly because of termite damage. The diluted insecticides were poured into the planting holes at the rate of half a gallon per point—enough to soak the soil. The following were the concentrations of the active ingredients in the dilutions: chlordane, 0.19 per cent; aldrin, 0.12 per cent; dieldrin, 0.09 per cent; gamma benzene hexachloride, 0.025 per cent. After a year there had been no losses due to termites among the stumps treated with chlordane, aldrin or dieldrin. Losses among the control plants and those treated with gamma BHC were not numerous but were enough to establish by contrast the value of the other treatments. The same insecticides were also applied in four fields of immature rubber, one in each field. Trees treated with benzene hexachloride were quickly reattacked, even within a month. In the other fields there has been a steep decline in the incidence of attack. In following up these results, chlordane, aldrin and dieldrin have been brought into use over most of the Experiment Station. Mature trees are being treated with two pints and immature trees with one pint of the diluted insecticides, while concentrations of the active ingredients are being reduced to find the most economic procedure. In these extended tests it has been extremely rare for a tree to be still attacked after treatment. Persistency in soil being the essential requirement for a good termite treatment, observations have been started on the toxicity after successive intervals of different soil types treated with known quantities of the various insecticides. All are quickly lost or inactivated in peat alone of the six soils selected.

MITES

Chlorparacide formulated as a wettable powder or as a miscible oil was without effect against the yellow tea mite (*Hemitarsonemus latus*) and Tetranychids when used at the recommended concentrations. On the other hand laboratory and field tests with dieldrin and endrin have shown both to be effective against *H. latus*. The predator *Typhlodromus newsami*, Tetranychid mites and *Brevipalpus* sp. were unaffected and bred normally on leaves sprayed with these two materials. For field control dieldrin requires to be used at a concentration of 0.05 per cent and endrin at 0.025 per cent though in the laboratory both were lethal even at a fifth of these concentrations. As these have absolutely no ovicidal action a second spray about five days later is required for complete control.

OTHER INSECTS

Coccids—Insect parasites and predators found attacking scale insects have been identified by the Commonwealth Institute of Entomology as follows. Two Coccinellid predators of *Saissetia nigra* were *Chilocorus politus* Muls. and *Telsimia* sp. Five Hymenopteran parasites that emerged from the same scale were *Aneristus ceroplastae* How. (Aphelinid), *Encyrtus barbatus* Timb. and *Cheiloneurus* sp. (Encyrtids), the last named probably a hyperparasite; *Anysis* sp. (Pteromalid) and *Melittobia* sp. (Eulophid). A Cecidomyiid found towards the end of last year feeding on eggs of *Pulvinaria maxima* has been identified as a species *Coccomyza* near to *C. leefmansi* (Nijveldt.).

Pests of legume covers—Sprays containing dieldrin (0.05 per cent), endrin (0.025 per cent), lead arsenate (0.5 per cent) and tuba root (1 pound in 12 gallons) were tested in a cover crop nursery for the control of the beetle *Pagria signata* (Eumolpid) and the bug *Chauliops bisontula* (Lygaeid). The first two alone gave good results. Lead arsenate scorched the leaves of *Pueraria* and *Calopogonium*. Calcium arsenate, which is cheaper, did the same in all the covers tested except *Centrosema*, and on rubber, with or without addition of slaked lime.

NEMATODES

Observations have been made in the Ampang Road nursery on the susceptibility to eelworm attack of four creeping covers including the three common ones and the recently introduced *Stylosanthes gracilis*. *Calopogonium*, on which nematodes were first seen in the area, was found to be highly susceptible. *Pueraria*, *Centrosema* and *Stylosanthes* were free from galls but in pot tests *Pueraria* was found to be susceptible. It seems that field tests are not entirely reliable, a conclusion also reached elsewhere.

Of twelve bush covers studied in the same nursery only *Flemingia congesta* and three species of *Tephrosia* (*maxima*, *candida*, *vogelii*) were found susceptible to eelworm attack after being grown for seven months in infected soils. Of these only *T. vogelii* was heavily galled. In pot tests another bush cover—*Clitoria laurifolia*—has been found susceptible too.

MISCELLANEOUS INVESTIGATIONS

Pollination of Hevea—Relatively few insect visitors to hevea flowers were found during observations made in the 1953 flowering season and there was little evidence of pollen grains adhering to their bodies. Inflorescences selected for observation were near the ground and much affected by mildew. In 1954 the flowering branches were ten to fifteen feet above ground and there was less mildew. Most of the insects were midges or thrips, the former more numerous in the afternoons, the latter in the mornings. They entered both male and female flowers, and some had pollen adhering to the body. Hairs similar to those clothing the midges were sometimes seen adhering to a stigma.

ADVISORY

Root Diseases

The subject with the greatest number of enquiries has been the recognition of the various root parasites. Some are indeed not easy to distinguish in the field without experience. All have now been described in *Planters' Bulletin* in articles which deal also with different aspects of control. It has been striking that when a serious root disease problem in a replanting has been brought to our notice we find the old stand to have been felled without poisoning the stumps. The value of stump (and tree) poisoning was shown many years ago, but it is only recently that the practice has been widely followed. The relative merits from the root disease point of view of different methods of clearing old rubber have been the subject of correspondence. The advice given in *Planters' Bulletin 10* remains valid though it is certain that the last has not been written on this subject.

Enquiries have also revealed an undue emphasis being placed on the fungicidal treatment used in the course of routine root disease control. The essential of control is cutting off the infected part of the root system. Lengths of root carrying a superficial growth of the fungus, with no penetration, have the fungus stripped off and a fungicide applied to kill off surviving fragments. The need for these last two operations has been suspect since it was shown experimentally that naturally infected root fragments must be of a certain size if they are to infect the roots of seedlings. Recent observations have shown that a few inches of rhizomorphs of *F. lignosus* remaining on the end of a cut root will die out without infecting the underlying root. It remains to be seen just how much infective material there must be, after the main source has been cut off, before the infection can proceed in isolation. Many planters at first do too

little about root disease in replantings in that control measures are not started soon enough. It is possible that later too much is done in that labourers are trained to take an unnecessary amount of care in searching out and burning the smallest pieces of diseased root, or in scraping off and treating with fungicide the slightest fragment of fungus which by itself is innocuous.

An unusual though not unique occurrence brought to our notice during the year has been an outbreak of *F. lignosus* on five-year-old rubber planted between rows of coconut palms which were poisoned with sodium arsenite three years later. To anyone familiar with the ramifications of coconut roots it is obvious that it is impossible to eradicate all potential sources of infection in such a case. The course advised was to dig isolation trenches to cut the rubber tree rows off from the rows of coconut stumps. Straight planting made it possible to dig the trenches mechanically.

Mouldy Rot

From time to time the suggestion is made that Fylomac 90, after an initial success, has failed to keep mouldy rot under control. In our experiments it has not failed but its use has been found to result in a conspicuous white bloom on the treated renewing bark due to harmless fungi growing in the outer and dead layers. This phenomenon may have given rise to suspicions as to the continued efficacy of Fylomac 90, the difference between the harmless saprophytes and the parasitic *Ceratostomella fimbriata* being unrecognised. Why the bloom is so obvious after treatment with Fylomac 90 is not known.

Some observations have been made on the effect of frequency of tapping on the severity of the disease, in an area where the alternate daily system had been changed to fourth daily at the beginning of the wet season with this effect in mind. When fifty selected diseased trees were changed back to alternate daily tapping the amount of mould increased markedly, while on those still under fourth daily tapping it was hardly to be seen. Another fifty trees put on to third daily tapping gave an intermediate response. It may therefore be advantageous in the wet season to reduce the intensity of tapping in areas where for some reason proper fungicidal treatments cannot be given.

Leaf Diseases

Immature clone PB 86 seems to be particularly prone to attack by *Gloeosporium* leaf disease, which may leave the trees without a good canopy between one wintering season and the next. No treatment is known at present for this condition, from which the trees recover in time.

Stem and Branch Diseases

Points of practical interest have emerged from a study of the control of pink disease. The asphalt-kerosene mixture containing 5 per cent of a wood preservative, as recommended for many years, has proved ineffective. Fylomac 90 has been found effective in the field at 0.5 per cent. Bordeaux mixture is seen to be about as good as Fylomac 90 and much cheaper, but it is not advised in tapped areas because of the danger of it contaminating the latex.

Spearhead dieback of one side of a bud shoot can occur as a result of an infection extending into it from the dead snag. It is rare.

Bark Bursts

Some clones exhibit a tendency for the bark to split and exude latex. Old BD 5 and PB 186 are bad in this respect, as is Gl 1 when growing on poor soil. Among recom-

mended clones the one that produces most bark bursts is PB 86, though RRIM 501 does it too. Sometimes the bark heals over and bursts again several times in the same place. Cutting across the resulting burr reveals thin layers of bark alternating with coagulated latex. The burrs are unsightly but nothing more, except at panel height where they would make tapping more difficult. It may here be worth while to cut them out, though there is no infection to be disposed of, bark bursts of this sort being brought about by physical strains, not by disease. Usually they are confined to the branches and the trunk above the panel.

Insect Pests

The success obtained with aldrin, dieldrin and chlordane on the Experiment Station has shown that they should be used in preference to mercuric chloride to control termites in young rubber by the liquid method. At recommended dilutions mercuric chloride costs several times as much as the other materials, of which two are locally available at present: Dieldrex 15 (used at 1 in 200) and Intox 8 (at 1 in 600) containing dieldrin and chlordane respectively. Aldrin has yet to come on the market in commercial quantities.

A noticeable feature of Coccid outbreaks brought to our notice has been the increased number that involved *Lepidosaphes cocculi*. There were it is true only seven reported, four of them minor, but previous to this there had been only three—one in 1937-8, one in 1951-2, one in 1953. All the major outbreaks were on PB 86 buddings about two years old.

Other Animal Pests

Doubt has again been cast on the suggestion that woodpeckers are responsible for the kind of injury illustrated on page 61 of *Planters' Bulletin* 3. A report has been received that a squirrel was seen cutting out the bark in the characteristic manner; later dissection revealed latex and bark fragments in the gut.

Distribution of Root Nodule Bacteria

A routine test of *Rhizobium* cultures maintained for distribution for inoculating legume cover crop seed showed that one of them had lost its ability to induce nodulation. Thirtyfive recipients of cultures that were suspect were circularised proposing a check on nodulation. Five of the fourteen replies received reported the absence of nodules, which was confirmed by examining specimens sent in. The estates concerned were furnished with fresh cultures for field inoculation—in the proportion of ten for every ineffective culture supplied. Three hundred tubes were sent out for this purpose, in addition to more than three thousand sent out in the ordinary way.

Summary of Advisory Work and Correspondence

Letters despatched	1276
Specimens examined	476
Visits to estates and smallholdings	182
Interviews	78

Arthur Newsam

Head of Pathological Division

Chemical Division

The graduate staff of the Division at the commencement of 1953 comprised Mr W. G. Wren (Head of Division), Mr G. W. Drake, Dr W. A. Southorn, Mr L. L. Best, Mr H. M. Edmondson, Mr R. S. Gale, Mr A. S. Cook, Mr J. E. Morris, Mr D. J. Graham, Mr P. F. Maher, Mr K. C. Sekar, Mr R. C. H. Hsia, Mr Cheah Sein Liat, Mr B. C. Sekhar, Mrs H. M. Overton (temporary appointment), and Mr S. J. Tata.

Dr R. Freeman, seconded from the British Rubber Producers' Research Association (B.R.P.R.A.), continued working in the laboratories throughout the year. Mr E. P. B. Edwards, seconded from Rubber Technical Developments Ltd., arrived in February and returned to the U.K. in December.

Mr B. C. Sekhar returned for duties in November after spending a year at the University of Michigan, U.S.A., and two months in the laboratories of B.R.P.R.A. on study leave. Mr Drake proceeded on home leave in September. Dr R. H. Smith resigned his post whilst on leave, Mr A. S. Cook resigned in May, Mrs H. M. Overton in June, and Mr Cheah Sein Liat in August.

Mr D. H. Taysum, (microbiologist), who had been undergoing a course of training in the U.K. for two years, took up his duties in Malaya in September.

Throughout the year liaison has been maintained between the Committee of Malayan Latex Technologists and the British Standards Institute Sub-Committee RUC/10/7, which deals with methods for latex testing. Liaison has also been maintained with Sub-Committee XII of the American Society for Testing Materials, Committee D 11, which deals with raw rubber.

The Head of Division and one member of the staff attended meetings of the International Rubber Research Board (I.R.R.B.) and International Rubber Development Committee (I.R.D.C.) held in Bogor, Indonesia, during March.

The Head of Division and two members of the staff attended the Rubber Quality and Packing Conference held in Singapore during April; three papers were submitted. A member of the staff attended the I.R.R.B./I.R.D.C. Autumn meeting, held in London in October.

Contributions to The *Biochemical Journal* were as follows:

The Phosphatides of the Latex of Hevea Brasiliensies by R. H. Smith.

1. Biochemical changes—March, 1954
2. Purification and Analysis—May, 1954
3. Carbohydrate & Polyhydroxy Constituents—May, 1954

Two papers were presented at the 3rd Rubber Technology Conference, London, June, 1954, 'Improved Rubbers by the Enzymatic Deproteinisation of Skim Latex' by J. E. Morris and 'Microgel in Latex and Smoked Sheet' by R. Freeman.

Articles published in the *Planters' Bulletin* were, 'White Latex Crepe', 'New Class Limits for Technically Classified Rubber,' 'Bale Coating Specification', 'Testing Latex Concentrates,' 'Dry Rubber Content of Latex', 'Latex Anticoagulants', 'Dry Rubber Content of Latex', 'Latex Concentrate', 'Skim Rubber—A Warning and a Request'.

The following Chemical Memoranda and Chemical Division Reports for limited circulation were issued: C/M 11/54 Mechanical Stability Testing of Latex Concentrate, C/M 14/54 Effect of Sulphuric Acid Coagulation on properties of Natural Rubber, Research Report No. 2—Latex Preservation, Research Report No. 3—Packing of Natural Rubber and Research Report No. 4—Effect of Yield Stimulant Application upon the Properties of Latex Concentrate and Dry Rubber.

The following publications and circulars concerning Technical Classification were published under the aegis of the International Rubber Research Board:

Historical outline of the development of testing Technically Classified Natural Rubber.

Technical Bulletins No. 32 & 33—providing technical and administrative instructions to testing stations and Research Institutes.

News sheet No. 7—Technical Classification of lower grades of natural rubber.

A review of progress in the Technical Classification of Natural Rubber. (Natural Rubber—1954).

Progress in the Technical Classification of Malayan Rubber (Interim Report for 1954, TC Note 8/54).

Technical Coordination of T.C. Rubber Production (Interim report for 1954. TC Note 9/54).

The following notes for local circulation were issued in connection with technical classification:

T.C. note 1/54 Provisional method of preparing technically uniform rubber.

T.C. note 2/54 Consumer response to T.C. rubber.

T.C. note 3/54 Costs of Technical Classification.

T.C. note 4/54 Technical Classification of Rubber in Malaya—Progress in 1953. (Rubber Quality & Packing Conference, Singapore).

T.C. note 5/54 Marking paints for bare-backed bales—general description (Rubber Quality and Packing Conference, Singapore).

T.C. note 6/54 Bale marking paints—formulations and trials.

T.C. note 7/54 & 8/54 Interim reports on progress of T.C. rubber in Malaya.

T.C. note 9/54 Technical coordination of T.C. scheme.

T.C. note 10/54 Technical Classification of packing house and remilled rubber—provisional instructions.

An account of work carried out by the Division is presented below in two sections. The first is headed 'Research Investigations' and records progress with the research and development problems which have been studied, including investigations of a fundamental nature, applied research and technical development.

The second section is headed 'Advisory and Development Work' and comprises a summarised account of advisory services and *ad hoc* investigations arising from producers enquiries, a resumé of the results of research which may be of immediate

interest to producers, an account of development work carried out on special and modified rubbers and a progress report on the Technical Classification of natural rubber.

RESEARCH INVESTIGATIONS

NON-RUBBER CONSTITUENTS OF LATEX

Microbiology

The survey of the microflora of hevea latex commenced at the end of 1952 has been continued and extended. Isolation of some one hundred and thirty different strains of latex bacteria has now been achieved. The work of confirmation is still proceeding, as it is considered essential that a thoroughly sound basis for future studies should be established.

Preliminary studies to demonstrate the biochemical activity of certain strains of bacteria were undertaken in the U.K., part of the work being carried out in cooperation with the B.R.P.R.A. Activity in respect of carbohydrates, pure protein, amino acids and lutoid fractions separated from latex was established; no activity was observed in respect of simple hydrocarbons of similar chemical structure to the unit rubber molecule. It was established that quebrachitol and meso-inositol were utilised for pigment formation by strains of *Serratia marcescens* (Bizio) isolated from hevea latex.

Progress in the work of surveying the bacterial flora of Malayan latices has been facilitated by the design and introduction of a synthetic culture medium consisting of a modified Kligler iron agar, which includes an indicator for acid-base changes and a simple variable redox potential system (usually thio-sulphate-sulphide) for anaerobes. Serial dilution of fresh latex inocula is completely effective on this medium.

It is of interest to record that micro flora of fresh hevea latex is remarkably similar to that of a bacteriologically poor water; this may be indicative of the major source of contamination in many instances.

A table of the species of bacteria (Eubacteriales) already observed in fresh latex is given below, together with known behaviour which may be of importance in determining their activity in fresh latex.

Class description	*Species*	*Dominant properties*
I Coliforms (occurring in large numbers in all fresh latices yet examined)	*Aerobacter aerogenes* *Aerobacter cloacae* *Intermediate Type I Coliforms* *Escherichia coli*	All capable of producing acid from quebrachitol, some from meso-inositol, non-proteolytic or very feebly proteolytic.
II Micrococci and Chromobacteria (of very variable occurrence. usually moderately rare but may become comparable in numbers to the Coliforms; the occurrence of this group seems definitely associated with individual trees).	*Micrococcus luteus* *Micrococcus flavus* *Serratia marcescens* (*Chromobacterium prodigiosum*) *Bacterium mycoides* (*Chromobacterium mycoides roseum*).	Moderately proteolytic and moderately active in the production of acid and gas from carbohydrates. Neither acid nor gas is produced from quebrachitol.

Class description	*Species*	*Dominant properties*
III Bacilli (initially rare or very rare in typical fresh latices).	*Bacillus cereus* *Bacillus cereus var. mycoides* *Bacillus subtilis* *Bacillus vulgatus* *Bacillus circulans* *Bacillus megatherium* *Bacillus mesentericus*	All strongly proteolytic, fermentation (acid and gas production) of (from) carbohydrates varies from moderate to very slight. Inactive towards quebrachitol and usually towards meso-inositol.
IV Staphylococcus (Usually moderately common).	*Staphylococcus aureus* *Staphylococcus aurantiacus* *Staphylococcus candidus.*	Moderately fermentative and proteolytic inactive towards quebrachitol and usually towards meso-inositol.
V. Miscellany (Variable occurrence see below).	*Zopfius zenkeri* *Proteus vulgaris* *Flavo-bacterium flavescens* *Flavo-bacterium arborescens* *Corynebacterium sp.* *Corynebacterium sp.*	

Group III, Bacilli, occurs only in small numbers in fresh latex and may be ignored during the first few hours required for tapping and collection. This no longer holds true after ammoniation.

Group V, miscellaneous, includes organisms for which a definite role cannot yet be forecast in regard to latex decomposition. *Proteus vulgaris* is of very variable occurrence and is often very rare. *Zopfius zenkeri* has been present in large numbers in every latex sample examined; it is inert to every substrate so far tested. The *Flavobacteria* range from rare to moderately common, the Corynebacteria are rare; both genera show feeble fermentative and proteolytic activity.

The fungi (Eumycetes) are very rare in fresh latex.

The situation in regard to ammoniated latices appears to be less complex, but more difficult to assess. Bacteria can be grown with ease from latices ammoniated to 0.5 per cent and fairly easily from latices containing 0.7 per cent. Unfortunately far less is known concerning the biochemical activity of those species found to be present. So far the most important fact which has emerged, is that ammoniation as normally practised in Malaya is not an efficient bactericidal process.

Enzymology

Work has continued on the survey of enzyme activity in hevea latex commenced last year. Studies have been carried out on fresh latex and on serum separated from fresh latex after coagulation by freezing; they have been confined largely to an examination of processes leading to the evolution of carbon dioxide from latex.

Fresh latex evolves carbon dioxide as soon as it leaves the tree and continues to do so at a fairly steady rate for some hours. Serum from fresh latex behaves similarly, but evolution occurs at a considerably higher rate. The reactions are considered to be enzymic in nature as little bacterial activity is likely to occur during the three or four hours following tapping, during which time carbon dioxide evolution proceeds steadily. Experiments to determine the number of bacteria present and others carried out on latex collected under sterile conditions confirmed this view.

Carbon dioxide evolution from fresh latex was found to be mainly anaerobic, the presence of oxygen causing a marked reduction in the rate. Maximum activity at 30°C was observed at a pH 5.6 in a phosphate buffer. Addition of the following reagents brought about a considerable increase in the rate of carbon dioxide evolution: sodium pyruvate, 3, 4-dihydroxyphenylalanine, -k 8 etoglutaric acid, succinate, fumarate, malate, phosphoglyceric acid, and glucose plus adenosine triphosphate. No effect was observed on introducing starch, glycogen, quebrachitol or meso-inositol.

Evolution of carbon dioxide was stimulated by the presence both of magnesium and of manganese ions; for certain types of enzyme activity methylene blue or similar activator appeared to be necessary.

The following substances exerted a positive inhibitory effect on the activity both in latex and serum; phloridzin, sodium azide, sodium fluoride, p-nitrophenol, semicarbazide, phenyl hydrazine and 3, 4 dinitrophenyl hydrazine. Both ammoniation and alkaline dialysis completely denatured the enzymes.

From the above observations, it appears that carbon dioxide is probably the common end product of a number of enzymic reactions. The system is obviously very complex and the above data suggest a number of mechanisms that may be proceeding.

In an attempt to clarify the position the following types of enzymic activity have been demonstrated and examined:

Pyruvate decarboxylating activity—The enzyme is strongly active in latex and serum, and is anaerobic. It requires to be activated by co-carboxylase (thiamine pyrophosphate) and magnesium ions. Inhibition is caused by sodium fluoride, semicarbazide, phenylhydrazine, 3, 4-dinitrophenylalanine. No inhibitory effect was exerted by p-nitrophenol.

The natural substrates and co enzymes present in latex serum can be removed by dialysis, when the enzyme becomes inactive. Activity can be restored by the addition of co-carboxylase, sodium pyruvate and magnesium ions. Alkaline dialysis resulted in denaturation of the enzyme.

-Ketoglutarate decarboxylating activity—This enzyme has been shown to be present in an active form in latex and serum. It requires magnesium ions and co-carboxylase for activation.

Inhibitors of pyruvic decarboxylase produce a similar effect on this enzyme.

3, *4-dihydroxyphenylalanine decarboxylating activity*—This enzyme appears to be inactivated in latex and serum by naturally occurring inhibitors which can be readily removed by dialysis. It is active under aerobic conditions and thus differs from that described by HOLTZ, HEISE and LUDTKE in 1938 (*Arch. exp. Path. Pharmak.* 1938, 87, 191).

The enzyme contains copper, which can be removed by dialysis against potassium cyanide, resulting in inactivity. The addition of copper ions restores activity.

Sodium fluoride, mono-nitrophenols, semicarbazide and phenyl hydrazine have a strongly inhibiting effect.

As well as the above decarboxylating enzymes, the following types of oxidising activity have been observed.

3, *4-dihydroxyphenylalanine oxidising activity*—The enzyme although present in serum is strongly inhibited; it becomes active after removal of the inhibitors by dialysis. It catalyses aerobic oxidation of 3, 4-dihydroxyphenylalanine, the end product being

a melanin-like pigment. Neither alanine nor phenylalanine are attacked by the enzyme.

It has been observed that the oxidation reaction is accompanied by decarboxylation and that substances inhibiting decarboxylation also inhibit oxidation.

The enzyme is dependent upon copper ions, but as far as in known, requires no co-enzyme.

Polyphenol oxidising activity—The enzyme is strongly inhibited in serum, but becomes active after dialysis of the serum under controlled conditions, pH 6 being the optimum. It is capable of oxidising pyrocatechol, phloroglucinol, pyrogallol and hydroquinone. It does not attack tyrosine, phenol and resorcinol. Hydrocyanic acid at low concentrations (0.05 per cent on aqueous phase) did not inhibit activity.

Ascorbic Acid Oxidising Activity

This enzyme was not found to be present in serum, although previous work in this laboratory indicated its presence in the lower fraction obtained by high speed centrifuging of latex.

The importance of the above studies in establishing means for controlling the changes occurring in fresh and ammoniated latex is apparent.

Considerably more work requires to be carried out, however, before anything like a clear picture can be built up regarding enzyme activity in latex.

CHEMISTRY & TECHNOLOGY OF LATEX

Preserved Latex

The study of latex preservation has been continued in the Division for a number of years, but the problem is a complex one and it is only during the past year or two that a systematic picture of the requirements has begun to emerge; the problem is still very incompletely understood.

In September, 1953, a provisional application was made for a patent to cover a preserving system based on three requirements:

mildly alkaline conditions,

a bactericide,

a sequestering agent for divalent metal ions, such as magnesium and calcium.

Further studies have now firmly established that the system is a sound one and a number of different reagents can be used for each of the three functions. Thus as bactericides, sodium pentachlorphenate, sodium trichlorphenate, zinc dimethyl dithiocarbamate were effective; other proprietary chlorinated organic compounds were also satisfactory. For the sequestering agent, ethylene diamine tetracetic acid, propylene diamine tetracetic acid, sodium salts of amino trimethyl carboxylic acid and trimethyl a . a' a' ' tricarboxylic acid (Trilon A and Trilon B respectively) were suitable. Other chelating agents were satisfactory at a slightly higher level of bactericide than that used with the abovementioned substances. In regard to the alkaline conditions, ammonia appears to be the most suitable reagent, but satisfactory results have been obtained with diethylamine; fixed alkalies such as potassium hydroxide were not so effective.

Other novel systems of preservation are being examined including one at neutral pH, some of which appear promising; further confirmation is required before definite conclusions can be reached.

Owing to the changes which proceed in latex after ammoniation, it is necessary to allow a period of some weeks to elapse before satisfactory evaluation of the properties of a given preparation of latex concentrate can be carried out. Attempts have been made to shorten this period by storing latex at a higher temperature, when the changes occurring are accelerated. A suitable accelerated test has not so far been established, but it is of interest to record some of the observations made.

Following ammoniation, the mechanical stability of latex increases rapidly for a few weeks and then more slowly over a period of months or perhaps years. Under normal shelf storage conditions in Malaya (say 28°C-30°C) the stability probably reaches a maximum between six months and one year. Thereafter a decrease in stability usually occurs. Experiments now show that when stored at 40°C, the maximum stability is reached after the comparatively short period of about four weeks, at 45°C after two weeks, and at 60°C after two or three days. It was also observed that the peak stability falls markedly with increase in storage temperature. Thus at 40°C a value of 1,000 was recorded, whereas at 55°C a value of 600 was obtained; at 60°C this had dropped below 300.

High temperature storage is thus likely to be highly deleterious to the properties of latex concentrate and care in transit where increased temperatures are likely to be experienced is obviously of great importance.

Volatile Fatty Acids

Improved methods of determining the volatile fatty acid content of latex have been sought, the most promising one yet investigated being the Conway microdiffusion technique. This method has the advantage of utilising simple apparatus and it takes only a short time for the operator to carry out the required procedures; as the test involves a stage of slow isothermal distillation, the overall time required to complete the test is no less than that required by the distillation methods previously employed. The Conway technique is, however, very sensitive and requires considerable skill in operation. Until this difficulty has been overcome it cannot be recommended for general use in factory laboratories.

A brief acount of the application of the VFA test to field and factory operations is given under 'Advisory & Development Work'.

Mechanism of Latex Coagulation

The automatic torsiometer built in 1953 to study changes in structure occurring in latex after acidification, has been operated satisfactorily during 1954. A further machine, capable of running three experiments simultaneously has been constructed, and is now in operation. More rapid progress is thus ensured, and much more accurate observations are now possible, as control tests can be run in parallel with any given experiment.

For simple coagulation of very lightly ammoniated field latex by acid, it has been demonstrated that the following factors affect the development of structure:

Origin of latex.
Time elapsing between tapping and addition of coagulant.
pH of serum at which coagulation is carried out.
D.r.c. at which coagulation is carried out.
Anticoagulants or preservatives added before coagulation.

Under normal conditions it was observed that the structure increases in strength steadily during the first hour or so, and continues to do so at a diminishing rate for about three days when a sudden rise in strength is found, the coagulum being kept under water throughout the period.

Under less acid conditions of coagulation a non permanent structure is sometimes built up rapidly, (within 15 minutes for instance), and then breaks down, to be followed by a steady rise in coagulum strength. This effect has been shown to be associated with the serum rather than the latex particles, and is thought to indicate that the first stage of coagulation does not directly involve the particles of rubber hydrocarbon.

The addition of formaldehyde to latex induces a marked increase in the rate of structure formation; the effect, however, is not lasting. Latex to which formaldehyde has been added and kept for twentyfour hours coagulates no more quickly than before adding formaldehyde. The effect of the formaldehyde reaches a peak value at room temperature, three to five hours after the addition is made.

Treatment of latex with trypsin also produces more rapid coagulation, the effect being reasonably permanent.

Syneresis of latex coagulum has also been studied and attempts are being made to correlate the results with torsiometer findings.

CHEMISTRY & TECHNOLOGY OF DRY RUBBER

Rubber Hydrocarbon

Earlier work carried out in the Division has demonstrated that variation in the rubber hydrocarbon is one of the least important factors affecting the quality of commercial supplies of rubber. Recent work has been directed towards establishing this point more firmly in the light of present day knowledge.

The property studied was molecular weight, which was determined by a viscometric method. Smoked sheet rubber was specially prepared for the experiment, considerable care being taken to ensure uniformity. It was demonstrated that with suitable precautions sheet could be prepared such that the intrinsic viscosity of samples taken from within any one sheet was substantially the same as that of samples taken from different sheets prepared in the same tank. The variation within a given sheet appeared to be random and attempts to correlate intrinsic viscosity with colour and with position in the sheet were not successful.

Having established the technique of preparation and testing, a preliminary experiment was made to compare smoked sheet rubber prepared with latex collected from trees of clones RRIM 501 and PB 86 over a period of two months. Results demonstrated a difference in viscosity between solutions of the smoked sheets which, however, was less than that observed for latex solution viscosity, obtained by direct solution of the corresponding latex in solvent. The difference was presumably due to the larger proportion of non-rubber constituents present in the latex solutions. It was further shown that viscosity determinations on solution of carefully prepared smoked sheet or on vacuum dried coagulum were less liable to variation than latex solution viscosities.

The work was then extended to cover sheet rubber prepared from some 60 different clones. The intrinsic viscosities observed ranged from 5.5 to 6.5, but most of the variation observed could be accounted for by differences in micro-gel content and in acetone extractable non-rubber substances. There was no evidence of any pronounced difference in molecular weight in the rubber hydrocarbon obtained from the different clonal trees.

It is of interest to record that in this series of rubbers no correlation between intrinsic viscosity and Mooney viscosity could be established, even after correction for micro-gel content and acetone soluble components. A relationship was found to exist between microgel content and hardness, determined by the Mooney viscometer.

Preparation of Rubber from Skim Latex

Following enquiries received regarding the preparation of skim rubber, experiments were commenced in 1953 to examine the factors controlling protein digestion by enzymes in the skim fraction from latex concentration. A number of proteolytic enzymes were tried, including ficin, papain, pepsin and many pancreatic extracts. The latter, embracing pancreatin and trypsin, were found to be the most effective, the optimum condition being pH 8 to pH 9.2, at 40 - 45°C. A period up to 24 hours was required for the digestion and for satisfactory results, the skim should not be more than two days old. Under these conditions one part of enzyme to about 10,000 parts of latex skim was found suitable. The addition of calcium ions (as calcium chloride for instance) at a concentration ranging from 0.005 M to 0.1 M was found to activate the digestion by 20 to 30 per cent. It was also observed that the copper content of the rubber finally obtained was markedly reduced by the introduction of calcium ions. This observation has proved to be of considerable importance, as skim rubbers often contain dangerously high levels of copper which can now be reduced to safe levels by the simple addition of calcium ions.

One advantage of this enzyme digestion process is that with skim of 4 per cent d.r.c. or higher, coagulation occurs as a result of the digestion process, yielding a coagulum which can be readily machined to produce sheet rubber.

Preliminary vulcanising tests indicated strain values similar to those of normal rubbers and hundredweight batches of enzyme treated skim rubber were prepared in the Experiment Station factory by a number of methods, employing the basic enzyme treatment. Samples were then despatched to the London Advisory Committee for transmission to manufacturers. Full reports have not been received, but preliminary indications suggest that the rubber has an abnormally low high elongation modulus, particularly in black stocks. Further development awaits the receipt of more complete reports on the material.

Test Methods

Dirt content of raw rubber—The attempt to formulate an internationally agreed test procedure for determining the dirt content of raw rubber, has made some progress during the year. The Division has made contributions both in the form of discussion and laboratory work. A comprehensive 'round robin' test conducted by I.N.I.R.O., has shown improved interlaboratory agreement, but details of the test procedure have still not been agreed.

Continued examination of sheet from certain Malayan estates produced over a period of sixteen months has established quite clearly that in many cases the level of dirt content remains constant over long periods.

Solubility of rubber powder in bitumen—For some years there has been a need for a standard test procedure to assess the properties of rubber powder prepared for use in bituminous road surfacing. Experimental work towards this end has been proceeding for a long time, but it was not until early 1954 that the Division finally developed a tentative specification for rubber powders, which was presented for discussion at the Bogor meeting of the I.R.R.B./I.R.D.C. in March. This was based on work carried out by sister institutes as well as ourselves, with the exception of the test proposed for solubility of the powder in bitumen, which was developed and tried out in the Division. Using this test the marked dependence of solubility upon powder particle size was clearly demonstrated, thus a fraction between 10 and 16 mesh B.S. took twice as long to dissolve as a fraction between 25 and 52 mesh B.S.

Methods assessing vulcanising behaviour—Considerable interest has been shown by technologists in the U.S.A. in the rate of vulcanisation as determined by the Mooney viscometer. It has been suggested that this method might be preferable to strain measurement as a means of technically classifying natural rubber.

Preliminary experiments have shown, however, that a relationship (non-linear) exists between strain measured on a dumbbell test-piece cured for 40 minutes at 140°C and rate of cure as determined from Mooney viscosity-time plots. The two tests thus appear to range rubbers in the same order. Further comparison indicated that the strain tests offer more powerful discrimination between rubbers. At present the proposed new test offers no advantage over the existing one.

In carrying out the strain test it has been observed that the dimensions of the mould used are of considerable importance, not merely in controlling the dimensions of the test-piece, which can readily be corrected, but also because abnormal dimensions are liable to induce variations in the degree of vulcanisation of the test specimen.

SPECIAL PURPOSE AND MODIFIED RUBBERS

Low Water Absorption Rubbers

Towards the end of the year requests were received from the L.A.C. for rubbers with good electrical properties, which were to be used in cable manufacture and had to compete with synthetic materials made for this purpose.

Attempts were made to produce low water absorption rubbers from twice centrifuged latex crepe, and from crepe prepared with trypsin digested latex concentrate. Experiments indicated that reduction of either ash or nitrogen content reduced the water absorption of the raw rubber; the effect on vulcanisates compounded to a cable stock formulation was less well defined. Reduced water absorption of vulcanisates was obtained, however, by the processes tried and 50 lb samples of crepes prepared by two methods have already been despatched for trials in the U.K. Further samples are being prepared.

Hardened Crepe

The preparation of crepe hardened by treatment of latex with a peroxamine redox system was described in the previous annual *Report*. The results of manufacturers tests have now been received and show that although a high Mooney viscosity was obtained, the crepes did not show the particular type of hardness required for shoe soling purposes. It is hoped to carry out trials with other methods of hardening.

Special Processing Rubbers

Interest has continued to be shown by manufacturers in the special processing rubber developed by the Division. Over three tons of rubber have been shipped to the U.K. in response to requests by consumers.

Application for a patent to cover the preparation was filed early in the year.

Rubber Lignin Masterbatch

During the year, a considerable effort has been made in investigating the commercial potentialities of rubber-lignin masterbatch, the results of which indicate that compounds can be prepared which should be of considerable interest to consumers. Service tests carried out in Malaya on shoe heel and soleing compounds have indicated one potentially useful product. It is understood that the possibilities of using the material in tyre casings is also being followed up by interested manufacturers.

The problems of producing the masterbatch have largely been overcome and a small pilot plant scale unit is at present under construction to establish the method and to provide the data required for costing the process and designing commercial scale production plant.

Graft Polmers with Styrene and Methymethacrylate

Graft polymers can be produced by polymerising certain vinyl monomers in the presence of rubber. As the name indicates, the new polymer formed is grafted on to the old one, giving a molecule with different properties.

The systems already studied in Malaya are fresh rubber latex with styrene and with methylmethacrylate, and the resulting products have been compared with materials produced with ammonia preserved latex in the British Rubber Producers' Research Association (B.R.P.R.A.) laboratories in the U.K.

The course of the reaction appears to be slightly different with fresh latex, polymerisation occurring more rapidly; thus polymerisation is carried out at 60°C in the U.K., whereas satisfactory results were obtained at 30°C in Malaya. It is thought likely that certain components of fresh latex influence the catalyst system used.

The process is a simple one and in the case of the styrene graft presents no difficulty. With methylmethacrylate grafts however, some trouble has been experienced in coagulating the latex after polymerisation. This can be overcome by high temperature coagulation; but alternative methods are being sought.

The final products obtained differ little in technological properties from those prepared by the B.R.P.R.A. Evaluation of molecular characteristics has yet to be completed.

It is concluded that large scale production in Malaya of graft polymers comprising rubber with styrene or methyl methacrylate should present no difficulty.

Cyclised Rubber

It has been recognised for some time that in the production of cyclised rubber masterbatch from skim latex, a considerable loss of material occurs during the creping operation. This problem has now been largely overcome by the use of slow-speed rolls, with relatively light grooving. In this manner the flocculant coagulum is kneaded and compressed to a more coherent mass, the finer floccules being washed away during machining. Higher yields and a product showing improved modulus have resulted.

Commercial production was being undertaken by five private companies at the close of the year.

FACTORY PRACTICE

Drying of Rubber

Construction of the experimental drying tunnel has been completed, and final adjustments for the control of temperature, humidity and rate of air flow are being made.

Preliminary experiments on the preparation of the coagulum in the form of sheet suitable for drying have demonstrated the anisotropic nature of machined coagulum, which is reflected in the dimensional changes of sheet on drying. Even so, the volume changes on drying agree well with that expected by calculation using the method of mixtures.

R.M.A. Conformance Tests for Bale Coating

An examination has been made of the conformance tests for bale coatings laid down in Amendment 1, 1 October, 1953, to the Type Descriptions and Packing Specifications for Natural Rubber adopted by the Rubber Manufacturers Association, New York.

Laboratory tests were carried out in Malaya on coatings specially prepared in accordance with R.M.A. recommendations; the bales were then shipped to the U.K. as a normal consignment and samples of the wrapper sheets removed and returned to Malaya for further tests on the bale coatings to determine the effect of shipment.

The Milling Test for Conformance of a bale coating was found suitable for distinguishing between starch or glue based and rubber gum based coatings, particularly if the samples were examined by reflected light. It did not differentiate between rubber-gum based solutions containing powders conforming to the specification and those close to but not conforming to the specification. The test could be rendered more exact by supplying 'type samples' depicting borderline and non-conforming bale wrapping sheets after the milling operation.

The Solution Test gave results differing widely from laboratory to laboratory. It was further demonstrated that bale coating solutions applied strictly in conformance with the R.M.A. recommendations gave rise to coatings which according to the Solution Test did not conform, and would thus be wrongfully penalised. It was recommended that the test should be withdrawn.

ADVISORY & DEVELOPMENT WORK

The volume of advisory work carried out by the Division has remained at much the same level as in previous years, although considerably more interest was shown in latex production and rather less in the manufacture of sheet and crepe. Office records show the following:

Subject		*Letters despatched*
Sheet production		399
Crepe rubber production		477
Latex production		931
Other processes		132
Technical classification of rubber		910
Research & others		461
Visits — advisory	169	
research & others	253	
Interviews	501	
Lectures to Planters' Associations	5	
Samples examined (excluding those examined in connection with T.C.R.):		
Latex hydrometers	118	
Customs' samples for d.r.c.	782	
Latex samples	1546	
Sodium bisulphite	24	
Coagulants	2	
Defects in sheet & crepe	201	
Others	114	

Latex Concentrate

Many of the problems dealt with during the year concerned latex concentration, for the most port by centrifuging. A number of new factories came into production and the trend still appears to be continuing. Most of the new factories have been well designed, particularly in respect of easy unloading on reception, ammoniation of field latex and concentrate, storage and drumming or bulk loading. Opinion in regard to centrifugal equipment appears to be equally divided in regard to the types at present available, an important factor in making a choice being high or low sludge content of the latex, which varies from district to district.

Problems arise chiefly in connection with maintaining output of a high quality, mechanical stability of the concentrate being the usual criterion. The adverse influence on quality of early putrefactive changes in field latex as indicated by the formation of volatile fatty acids (VFA) has been widely discussed with producers by officers of the Division and its importance is now generally recognised. The VFA No. test has been used many times to trace back the sources of infection in factory installations and field operations. In almost every case such an investigation has resulted in an improvement of quality.

Several cases of inherent instability of latex have been encountered, however, more particularly in flat coastal areas. The type of clonal tree and in some cases the tapping system employed have been found to influence stability. Methods are usually available for correcting these defects, but rely mainly upon good field and factory hygiene.

Putrefaction occurs in field latex due to bacterial contamination. It has now been established that 0.3 per cent ammonia is insufficient to give a positive bactericidal effect. VFA formation in field latex can be suppressed only by 1.0 per cent ammonia; in latex concentrate 0.65 - 0.70 ammonia is the minimum requirement. Lower quantities of ammonia reduce putrefaction, but by no means prevent its occurrence. The importance of early and adequate ammoniation in the field with a view to reducing the proliferation of bacteria cannot be stressed too strongly. The avoidance of further bacterial contamination from factory equipment is equally important and calls for daily sterilisation of all equipment used whenever possible.

An examination of latices from certain areas or from known clones in respect of suitability for the preparation of latex concentrate has been undertaken, part of the work being carried out in cooperation with the Botanical Division; most of the clones of the RRIM 600 series are included.

The effect of ladder tapping on the quality of latex has also been briefly studied. Only in one case was any effect observed; concentrate prepared from Tjir 1 clones was found to show a lower mechanical stability when the latex had been harvested by ladder tapping. The observation has yet to be confirmed.

Observations on the effect of storage at increased temperature upon the quality of latex concentrate may be of importance in connection with shipment. It was found that an increase of temperature caused more rapid ageing of the latex; the mechanical stability increased more rapidly, reached a maximum value, and started to decrease again within a shorter time. Under normal conditions of storage in Malaya, decrease in stability does not usually occur before six months to one year; in cooler climates the period may be much greater. It has now been established that at 40°C maximum stability may be achieved within 28 days and at 50°C within 6 days. Thereafter the stability commenced to decrease. It was also noted that the higher the temperature of storage, the lower was the maximum stability obtained. It is apparent that if high temperatures are reached during shipment, the quality of the latex may suffer considerably, and attention of shippers should be drawn to this fact.

An examination has been made of latex and rubber from trees treated with a yield stimulant, 2,4,5-trichlorophenoxy acetic acid, (2,4,5-T). The trial was carried out in Field 23 at the Experiment Station in cooperation with the Botanical Division. Comparison of latex and rubber from stimulant treated and untreated control trees showed that the technological properties of latex concentrate were unaffected by the treatment. A small increase in copper content of the field latex was observed (the increase being 4 to 7 p.p.m.) but this was much less marked in latex concentrate and in dry rubber prepared from the latex; the highest increase recorded in the final product was 2 to 3 p.p.m., observed only in one instance. Examination of crepe for softness and ageing properties gave rather inconclusive figures, which were statistically not significant.

The technical properties of a tyre tread stock made with smoked sheet from control and treated trees were identical; after ageing the vulcanisates for 14 days, the change in physical properties was the same for both types of sheet.

It may be concluded that no obvious harmful effect upon the properties of latex or dry rubber has yet been observed as a consequence of treating hevea trees with yield stimulant 2,4,5-T.

Sheet and Crepe

Enquiries concerning crepe production have to a large extent been concerned with the R.R.I. bleaching process for preparing pale crepe. Difficulties in obtaining supplies of the bleaching agent were experienced during the year and made production difficult, but with supplies readily available renewed interest in the process was shown towards the end of the year.

Trials to establish the optimum amounts of reagent have ben made on behalf of a number of estates. If care is taken in using the method, the defects experienced, viz., poor lamination and colour change on storage, are usually avoided.

In sheet production, the major problems experienced appear to concern precoagulation and bubbles. Enquiries dealing with factory machinery and smokehouses were concerned chiefly with individual and local problems.

In spite of the development of alternative processes for producing an improved rubber from latex skim, the most popular method of treatment is still coagulation with sulphuric acid. It has been found that the addition of 0.03 per cent of sodium bisulphite to the skim as soon after centrifuging as possible, will help to produce a pale coloured crepe. Emulsion A concentrate will bleach the yellow colour, but the process cannot be recommended on economic grounds. The use of strong sulphuric acid for skim coagulation does not appear to darken the rubber appreciably. It is found that a crepe blanket may be formed more readily if warm water is used on the creping mills.

Special and Modified Rubbers

A number of special and modified rubbers have been studied during the year, some of which have reached the stage of commercial production.

Improvements in the method of machining cyclised rubber have led to higher yields and a superior product. Five private companies had undertaken commercial production by the end of the year. The material has application in shoe soling, where it competes with high styrene synthetic polymers such as Neolite. Other applications are being considered.

Rubbers with special processing properties have been developed in the Division during the past two years. Considerable interest has been shown in these rubbers by manufacturers using extrusion processes, such, for example, as in cable production. More than three tons of the rubber in the form of crepe has already been shipped to the U.K. for trial in response to consumers' requests. Preparation in the form of sheet, if possible, is obviously desirable on the basis of lower cost; unfortunately the properties of the sheet material are at present not so satisfactory as those of the crepe. Further investigation is required before a satisfactory quality of special processing sheet can be produced.

Interest in rubber-lignin masterbatch continues and possible applications have been examined; of these shoe sole and heel stocks are promising. The possibility of use in tyre side walls is also under consideration. A pilot plant to produce hundredweight quantities is being erected.

Requests have been received for rubbers with good electrical properties for trial in competition with synthetic alternatives. Samples of partially purified rubber with low water absorption have been forwarded for test, and work is proceeding in an attempt to produce even better products from natural rubber.

The possibility of improving the properties of the natural rubber molecule by grafting on to it comparatively small additions of a synthetic polymer has been investigated both in the U.S.A. and by our sister institute, B.R.P.R.A. Satisfactory grafts were prepared in the U.K. using styrene and also using methylmethacrylate as the added substance. It has now been demonstrated that the graft materials can be satisfactorily prepared in Malaya from fresh latex, the process proceeding more readily than with the ammonia preserved latex used in the U.K. Problems in coagulating certain of the graft polymer latices have now been overcome and pilot plant scale production can be undertaken if a demand for the materials arises. The method of operating the process and the equipment required for production are both simple and could be undertaken by many estate factories with existing facilities.

Technical Classification of Natural Rubber

Throughout the year Technical Classification on Malayan produced rubber has been continued by the Division. In the first half of the year, the amount classified was less than for the preceding six months of 1953, due mainly to a number of large estates turning from the preparation of dry rubber to concentration of latex.

In the last six months of the year, however, production of T.C. rubber increased, owing largely to a greater output from packing houses and remilling factories.

During the year 135 estates have attempted to produce T.C. rubber; 117 of these are currently submitting samples and 108 are exporting marked bales. Most of the agency houses and estate groups in Malaya are able to supply T.C. rubber, several organisations trying to export all their dry rubber production in this form. A small survey of 147 estates in Selangor indicated that about 70 of those producing baled rubber were co-operating in the T.C. scheme.

The total production from estates during 1954 is estimated at 32,000 long tons, mainly in the types RSS IX & 1, but significant quantities of air dried sheet, thin pale crepe and estate brown crepe have also been technically classified.

In the period under review ten packing houses (one in Singapore, the rest in the Federation) have cooperated with the Division and produced over 4,000 tons of T.C. rubber mainly in the types RSS 1 to 5.

A new method of producing small lots of rubber having uniform technical characteristics has succeeded in dispensing with a large part of the extra handling previously needed for sheet blending. The method can be fitted into the normal packing house routine with little reorganisation and after practice over 90% of the lots sampled can usually be classified. The average technical uniformity of the consignments prepared in this manner is of the same order as that of well-controlled estate shipments. The association between colour and technical properties found in some packing houses, has also been used to produce consignments of predictable classifications. The baling of light coloured RSS 3 generally gives lots with medium vulcanising characteristics (yellow class) whereas the use of dark coloured sheet results in lots with high modulus, (blue class).

Although these recent innovations have reduced the costs of production, the expenses, due to the occasional extra storage, handling, sampling, sample despatch and marking, continue to cause the packer to restrict production to meet definite orders.

Five remilling factories have submitted samples during the year, three of which are known to have made shipments of T.C. thin brown crepes. The total production for the year was about 1,000 tons which has mainly been prepared to fulfill definite orders from consumers.

There is no practical difficulty in controlling the uniformity of remilled rubber, provided that care is taken to exclude skim coagulum. The blending which occurs during the milling and washing operations is sufficient to ensure homogeneity of the lengths of crepe within a batch. A large consignment of remilled rubber was successfully treated by dipping to change the rate of vulcanisation from medium to fast to meet a special order from a rubber manufacturer.

The R.R.I.M. has been responsible for the technical coordination of the production of T.C. rubber in the Far East since 1 January, 1954, under the auspices of the IRRB/IRDC. Several general documents have been prepared, and advice given to a number of Research Institutes on the preparation and testing of T.C. rubber. Towards the end of the year an inter-laboratory test was organised including 7 testing stations in 4 different countries; the results of the tests indicated that considerable progress has been made towards reducing inter laboratory errors and that further improvements can be achieved.

The revised system of marking T.C. rubber, indicated by the new symbol now in use, was introduced by the International Rubber Research Board at the beginning of the year. It has proved successful in ensuring the maximum output from the Malayan units cooperating and at the same time offered a more technically uniform raw material to consumers.

W. G. Wren
Head of Chemical Division

Smallholders' Advisory Service

Mr L. R. Davidson was granted four and a half months accelerated long leave from 24 August. Mr J. M. F. Greenwood who was on duty throughout the year acted for the Smallholders' Advisory Officer during his absence. Mr J. W. L. Bevan's secondment to the Joint Working Party of the Rubber Industry and Government continued up to the end of May when he returned to the Rubber Research Institute. Senior officers spent 133 days in field inspections with Rubber Instructors. This amounted to 20 per cent of working time and while an increase is desirable it can be expected only with increased supervisory staff throughout the year.

With effect from 1 January, 1954, three Superintendent Rubber Instructors and seven Rubber Instructors resigned from the service of the R.R.I in order to continue duties previously undertaken on secondment to the Rubber Industry (Replanting) Board. Another Rubber Instructor left the service of the R.R.I. to take up an appointment with the R.I.(R.)B. on 1 June.

Only two Rubber Instructors were on long leave during the year while one Rubber Instructor was on medical leave for over seven months. One transfer of station took place during the year. The recipient of the only R.R.I. scholarship to the College of Agriculture in 1951 successfully completed the diploma course and was appointed Rubber Instructor on 3 May. After initial training at the R.R.I. Experiment Station he was posted to Malacca. The total number of Rubber Instructors in the Service at the end of the year was 31.

Eleven Junior Rubber Instructors were appointed from young men who successfully completed a three month course of training which ended on 31 March. Training of Junior Rubber Instructors continued in the field under the close supervision of senior Rubber Instructors and only after a final course at the Experiment Station at the beginning of November were they posted to their first stations. There were thus twelve Junior Rubber Instructors at the end of the year allocated as follows: Selangor one, Johore one, Kedah two, Trengganu one, Perak three, Pahang two, Kelantan two.

One Rubber Demonstrator died during the year and six resigned four of whom secured more renumerative employment with the R.I.(R.)B. and one with the Department of Agriculture. Rubber Demonstrators in the Service at the end of the year totalled 24.

Early difficulties in securing land for Rubber Instructors' houses began to be overcome during the second half of the year when more, personal, visits to Land Offices were made. By the end of the year applications in four districts had secured us alienation, or access with the promise of alienation, of land suitable for the erection of six houses in priority stations. In two other stations prospective sites for three houses on land offered by Government awaited inspection and in two districts requiring three houses offers of private land for sale required further investigation. In three stations, Kuantan, Kota Bahru and Segamat, where houses are badly needed, there was no immediate prospect of obtaining suitable land.

One special meeting of the Smallholders' Rubber Advisory Committee was held in August to consider possibilities of increasing the efficiency of the Smallholders' Advisory Service by changes in the system of supervision.

Assistance given to the Working Party, which prepared information for the Rubber Enquiry Mission, through the secondment of Mr Bevan up to the end of May has been noted above. His assistance continued to be required on occasion after this date both by members of the Working Party and the Rubber Mission when it arrived. Rubber Instructors contributed to the efforts of the Working Party by undertaking all necessary

interrogations for the pilot survey of medium holdings. For each Rubber Instructor in West coast territories the task of identifying holdings in the sample and recording the required data amounted to two or three weeks' work. As a direct result of the availability of Rubber Instructors for this task the Working Party was able to investigate conditions and costs in much greater detail for the medium holding pilot survey than was practicable in the pilot survey of smallholdings.

Two members of the Department of Agriculture in Thailand visited Malaya for four months between May and October in order to study methods of rubber production. A course of instruction was organised under the guidance of Heads of Divisions and the Manager of the Experiment Station and arrangements were made for them to visit estates where they could see various types of factory equipment in operation. The whole of the month of September was devoted to visiting selected Rubber Instructors and studying smallholders' problems.

ADVISORY

Manufacture

At the beginning of the year Rubber Instructors were directed again to work on the processing of rubber and particularly to encouraging centralised processing. Those places which had formerly established schemes for handling smallholders' latex in bulk on a sound basis were generally found to have continued this work satisfactorily. Some schemes had failed and some were re-established during the year. The Table below gives the figures for smallholders' rubber purchased as latex by large commercial organisations and that processed into sheet rubber at or near the collecting centres.

	Collected for sale as latex	*Collected for sheet manufacture*
	Tons	Tons
Selangor	1,174	235
Negri Sembilan	433	19
Malacca	15	30
Perak	27	207
Johore	1,650	536
Pahang	25	89
Kedah & Perlis	259	90
Total	3,583	1,206

Planting

As indicated in the 1953 *Report*, the best chance of improving replanting standards on smallholdings lies in close collaboration with officers of the Replanting Scheme at all levels. We have done our best to assist and advise the Scheme on technical aspects of rubber growing and Rubber Instructors have visited smallholders, replanting wherever required.

The replanting grant provides a powerful incentive to better work by smallholders. It is therefore disappointing to note that such a larger proportion of the grant can be paid

out in the early stages of replanting. Forty per cent is utilised in the first six months and the whole grant can be handed over by the time the rubber is only four and a half years old when further manuring and cultivation may be required to bring an area successfully to maturity. From experience of smallholders' planting in the past it would be provident to reserve a small proportion of the replanting grant for payment only when the trees have reached an accepted standard for tapping. There is a considerable danger that a large part of the effort of replanting will be wasted by the early tapping of trees by smallholders.

The possible value of tree poisoning in reducing labour requirements for replanting was kept clearly in view throughout the year. As Botanical Division investigations on the use of 2,4,5-trichlorophenoxy acetic acid proceeded, further trials and demonstrations were set up on smallholdings. It thus proved possible to advise the R.I.(R.)B. of a satisfactory and economic method of killing rubber trees with 2,4,5-T in time for poisoning to be carried out, if required, before the main planting season. At the same time demonstrations of the effectiveness of 2,4,5-T were available in several parts of the country. Demands from smallholders were not large but sufficient requests were made to enable demonstrations to be given in most districts.

New planting by smallholders generally was discouraged during the year, in some territories by the closing of Land Office books to new alienation and in others by difficulties in obtaining supplies of planting material. Total new planting recorded by Rubber Instructors shows a decline of 50 per cent or over 3,000 acres, on the figures for the previous two years and is only 60 per cent of the amount planted in 1951. This decline is a serious matter for certain States for which new planting is of more immediate importance than replanting; it must be offset against their achievements in replanting.

The Table below shows the acreages of new planting, new planting with clonal seedlings and budgrafting on new plantings which have been recorded by Rubber Instructors during the year.

New Planting Reported by Rubber Instructors 1954

State	Total new planting	New planting with clonal seedlings	Budgrafting on previous new plantings
Selangor	—	—	—
Negri Sembilan	389	263	309
Malacca	—	—	—
Perak	434	188	320
Johore	379	10	188
Pahang	1,091	678	673
Kedah/Perlis	487	401	118
Penang & P.W.	—	—	—
Kelantan	428	190	180
Trengganu	152	135	3
Total	3,360	1,865	1,791

Planting Material

The extent of budgrafting and use of clonal seedlings for new plantings is shown in the Table. Of the total new planting observed 55 per cent has been planted with clonal seedlings. On replantings which have come under Rubber Instructors' scrutiny approximately 75 per cent of areas have been planted with clonal seedlings. In this connection it should be noted that replantings include a high proportion of relatively large holdings which can hardly be considered strictly in the peasant category whereas new planting is being done almost entirely by people of small village communities in relatively inaccessible locations. Their need for assistance is proportionately greater than the large majority of replanters and good reasons can be adduced for giving new planters priority in the supply of clonal seedlings. New land cleared from jungle contains a large number of plant species which are predominantly bushy and regenerate with the growing rubber to provide good, easily controlled natural covers; clonal seedlings planted on such land can grow to maturity with little attention. The operation of budgrafting on the other hand requires a drastic clearing of the area to allow access and to ensure that developing budshoots are not retarded by shade. Land for replanting generally does not produce the desirable bush plants for a natural cover; dependance is on creepers whether natural or introduced. This type of cover and the needs of regular manuring demand maintenance of cleared areas round the rubber plants so that budgrafting on such sites does not involve an extra clearing operation.

During the period 1 January to 30 June over two and three quarter million clonal seeds were collected under the supervision of Rubber Instructors and distributed to Agricultural Department nurseries. Thereafter responsibility for collections was taken over by the Department but, owing to lack of suitably trained personnel in the Department, our supervision of routine collections continued in many instances after the end of June. The R.R.I. continued to investigate potential new sources of supply of clonal seeds, informing the Department of Agriculture where new areas could be approved. Examination of areas on thirtythree estates which had not previously provided clonal seed was carried out during the year. Thirteen estates were approved as sources of clonal seed, eight were rejected and examination of twelve was not completed before the end of the year.

Over sixtyone thousand yards of budwood were cut and despatched from the smallholders' nursery at the R.R.I. Experiment Station. During the main seedfall all seeds from collecting areas in Fields 5 and 18 on the Experiment Station were collected and distributed for use in smallholders' nurseries for new planting. The total distributed was in excess of three hundred and sixty thousand.

INVESTIGATIONS

At the R.R.I. smallholding in the mukim of Ampang, replanting trials previously established were maintained and records taken as required.

Girth measurements in the 1948 and 1949 hedge plantings in which three fourths of the old rubber trees were originally retained showed that the overshading of the young rubber plants was having a serious effect on growth. During the year the stand of old trees was reduced to 25 per cent of the original by poisoning and in the second half of the year there was some improvement. The effect of closeness of trees along

the hedges may also now be expected to retard growth and thinning out will be undertaken in 1955. The girth measurements at 60 inches and increments, in inches, of these replantings and of the 1950 replanting of hedge rows in pollarded old rubber are shown below.

	December 1953	*June 1954*	*December 1954*	*Annual increment*
1948 double rows 3ft x 4ft	6.6	7.2	8.3	1.7
1948 double rows 4ft x 4ft	8.3	8.9	10.1	1.8
1949 double rows	6.3	7.0	7.8	1.5
1950 4ft x 54 ft	6.0	8.1	9.2	3.2

The pollarded old rubber continued to yield approximately 40 per cent of the original yield of the area but bark reserves are approaching exhaustion. Girth measurements showed that the beneficial effects of pruning the old trees and re-opening root isolation trenches in the last months of 1953 wore off during the year. Complete destruction of the old trees will be carried out in 1955.

Advantage was taken of the need to destroy numbers of trees to provide material for Botanical Division tests of 2, 4, 5-T as a tree poison. A satisfactory method of tree killing which could be economically adopted on smallholdings was developed.

During the second half of the year Mr Bevan established ten case-studies on costs of replanting. Six Rubber Instructors were responsible for the collection of data from these replantings and by the end of the year information on operations up to planting has been received. These studies will be continued so that information on maintenance procedures and costs can be obtained. Distribution of the case studies is as follows:

Johore three, Malacca two, N. Sembilan three, Selangor two.

INFORMATION

The establishment of the Replanting Scheme for smallholders has shown the need for technically well trained workers to support any organised economic assistance for smallholders. Training of workers who can assist smallholders in any field of development is therefore accepted as an R.R.I. task. In January a training course for twentyseven young men who had reached Standard VII at English schools was commenced at the R.R.I. Experiment Station. The course lasted three months and sound instruction and practical experience were provided in all fields of rubber growing and processing likely to be applicable on smallholdings. An immediate aim of the course was to train recruits to our new cadre of Junior Rubber Instructors and eleven of the trainees were selected for these appointments. The balance found employment in the Replanting Scheme.

In September a course of instruction in planting techniques was held for twentyone young men who had been selected by Rubber Instructors from candidates in their districts. These men were smallholders or the sons of smallholders and able to apply their knowledge immediately, providing samples of good work as an example to others.

These trainees found their own maintenance expenses while in residence for four weeks at the R.R.I. Experiment Station. At the conclusion of the course graded certificates were presented to those who had reached appropriate standards in examinations.

In view of the success of the course for smallholders at Sungei Buloh it has been considered that this type of work could usefully be increased. We would like to make it possible for Rubber Instructors to organise such courses in their own districts. The greatest impediment to development on these lines is the absence of facilities and material for instruction and practice. Good prospects were found at Batu Pahat for a pilot course for training smallholders. A nursery and field plantings were available on private land and there was keenness amongst the local young people for a position on the course. A start was made before the end of the year with a course on instruction occupying every Sunday for a period of six months. This course, for Chinese speaking men, is under the direction of the Chinese Rubber Instructor, Batu Pahat. Another course for Malay speaking smallholders was commenced in October by the Malay Rubber Instructor at Muar. This utilised the holding of a Penghulu which was being replanted by the trainees who are all students of the religious school at Parit Medan. We hope, on the experience obtained at Batu Pahat and Muar, to be able to design courses which can be adopted by Rubber Instructors to suit the rural population in any part of the country. The key to such courses is the availability of material for demonstration and practice.

Only six of our replanting demonstrations now qualify as exhibits to the public. The others have been removed from our list, for neglect of maintenance, or because the owners insisted on tapping before the trees were mature; some areas have been lost through requisitioning of land for new village extensions or other Government requirements.

Budwood has been supplied free from the R.R.I. to secure the early establishment of areas of newly approved or promising clones. Altogether nineteen smallholdings have been assisted in this way. Some of these are developing budwood nurseries for field budding in one year's time, others have been budded direct in the field. The majority have received budwood of clone RRIM 513 for comparison with PB 86, RRIM 501 or Tjir 1. A few relatively small areas have been given RRIM 526, and RRIM 527 or PR 107.

More District and State agricultural shows were held during 1954 than in any year since 1948. Rubber Instructors arranged exhibits for the shows in their districts. At the Malayan Agri-Horticultural Association show at Kuala Lumpur from 7 to 9 August, the Smallholders' Advisory Service acted as coordinators for the Institute exhibit. Parts were contributed by the Technical Classification and Publications sections and by the S.H.A.S. The S.H.A.S. exhibit on centralised processing was used also at Klang and Raub District Shows.

A leaflet describing the method of poisoning rubber trees with 2,4,5-T was prepared for publication by the R.I.(R.)B. A first draft of a manual on replanting was completed during the year. Arrangements for translation and printing had to be left over to 1955.

The series of R.R.I. vernacular films was used at the M.A.H.A., Klang and Raub shows and in conjunction with the two training courses at the Experiment Station and the extension course at Batu Pahat. The films were also shown to kampong audiences in Batu Pahat district and by mobile units of the Department of Information in the Muar, Temerloh and Taiping Districts. Further shows were not possible owing to the pre-occupation of the Department of Information with propaganda work concerning elections and the emergency.

The initial screening of our films by the Department of Information has provided valuable publicity on subjects of considerable importance to smallholders. For support in the detailed extension work now to be undertaken, for which the films were primarily designed, the public screenings by the Department do not provide the best forum for instruction in agricultural subjects. The films are of special value only to persons with a particular interest in the subject matter. For these, screenings followed by discussions in small groups is the method which may be expected to give the best results. For this reason we are anxious to have our own mobile projector which will support Rubber Instructors in turn in their extension work.

L. R. Davidson
Smallholders' Advisory Officer

SENIOR STAFF AND GRADUATE ASSISTANTS

ADMINISTRATION

C. E. T. Mann, M.Sc., F.I.R.I. *Director.* (First appointed 15 June 1927)

C. G. Akhurst, B.Sc., A.R.C.S., A.I.C.T.A. *Deputy Director.* On leave from 15 June. (First appointed 7 October 1930)

H. S. Blacklin. *Secretary.* (First appointed 1 March 1932)

J. C. Reeves, F.C.C.S., *Assistant Secretary.* On leave 1 February to 2 November. (First appointed 1 September 1950)

PUBLICATIONS SECTION

D. R. Rexworthy, B.Sc., F.R.I.C. *Publications and Information Officer.* (First appointed 23 July 1952)

STATISTICS SECTION

D. R. Westgarth, M.Sc., *Statistician.* On leave until 4 March. (First appointed 3 August 1950)

Fong Chu Chai, R. C. D. *Assistant Statistician.* On study course in England. First appointed 8 July 1949)

D. K. Dutta Ray, M.A. *Assistant Statistician.* (First appointed 22 May 1952)

EXPERIMENT STATION

R. F. Harley, M.C., A.I.S.P. *Manager.* On leave from 1 September. (First appointed 27 August 1937)

A. E. Browne, M.C., *Assistant Manager.* Acting Manager from 1 September. (First appointed 1 February 1948)

J. E. Ellison, *Assistant.* (First appointed 10 July 1951)

G. A. D. Hooper, *Assistant.* Resigned with effect from 1 March. (First appointed 5 February 1952)

J. D. Macritchie, B.Sc.(Agr). *Assistant* from 15 December. (First appointed 15 December 1954)

SOILS DIVISION

G. Owen, M.Sc., *Head of Division.* On leave from 1 September to 2 October. (First appointed 5 January 1939)

E. W. Bolle-Jones, M.Sc., Ph.D., *Plant Physiologist.* (First appointed 20 August 1952)

G. M. F. Grundy, B.Sc. *Soils Chemist.* (First appointed 5 January 1953 after a year's study in Trinidad and England)

(Vacant) *Soils Chemist*

BOTANICAL DIVISION

E. D. C. Baptist, M.Sc., Ph.D., A.R.C.S., D.I.C. *Head of Division.* (First appointed 20 March 1935)

H. M. Burkill, M.A. *Botanist.* Resigned with effect from 24 May. (First appointed 1 July 1948)

C. W. Brookson, B.Sc. *Botanist.* On leave until 26 March. (First appointed 23 August 1949)

P. de Jonge, Agr. Ir. *Botanist.* On leave until 28 July. (First appointed 29 December 1950)

J. S. Lowe, Ph.D. *Plant Physiologist.* (First appointed 11 February 1953)

P. R. Wycherley, Ph.D. *Botanist.* (First appointed 26 January 1953)

T. V. Vaidyanathan, B.Agric. *Assistant Botanist.* First appointed 1 May 1935)

V. K. Bhaskaran Nair, M.Sc. *Assistant Botanist.* (First appointed 26 May 1952)

PATHOLOGICAL DIVISION

A. Newsam, Ph.D. *Head of Division.* (First appointed 5 April 1947)

F. W. Hutchison, N.D.A., C.D.A. *Field Research Officer.* (First appointed 5 March 1948)

R. N. Hilton, M.A. *Pathologist.* (First appointed 7 September 1948)

R. A. Fox, B.Sc. *Microbiologist* from 2 March. (First appointed after a year's study in England)

K. P. John, B.A. *Assistant Pathologist.* (First appointed 16 November 1936)

B. S. Rao, B.Sc. *Assistant Entomologist.* (First appointed 6 June 1952)

CHEMICAL DIVISION

W. G. Wren, B.Sc., A.R.C.S., D.I.C., A.I.R.I. *Head of Division.* (First appointed 7 January 1950)

G. W. Drake, B.Sc., M.A. *Chemist.* On leave from 1 September. (First appointed 8 March 1948)

W. A. Southorn, Ph.D., A.R.I.C. *Chemist.* (First appointed 18 November 1952)

A. S. Cook, B.Sc., A.R.I.C. *Organic Chemist.* Resigned with effect from 11 May. (First appointed 25 February 1949)

J. E. Morris, B.Sc. *Chemist.* (First appointed 20 June 1952)

H. M. Edmondson, B.Sc. *Technologist.* On leave until 28 February. First appointed 28 August 1950)

R. S. Gale, B.Sc., A.C.G.I., A.M.I. Chem. E. *Chemical Engineer.* (First appointed 2 May 1951)

D. J. Graham, *Chemical Engineer.* (First appointed 31 March 1953)

L. L. Best, M.Sc., A.K.C. *Technologist.* First appointed 7 March 1952)

P. F. Maher, B.Sc. *Technologist.* (First appointed 19 June 1953)

D. H. Taysum, M.Sc. *Microbiologist* from 13 September. (First appointed after two years' study course in England)

R. F. J. Freeman, Ph.D. *Chemist* seconded from British Rubber Producers' Association. (First appointed 1 May 1952)

E. P. B. Edwards, A.I.R.I. *Technologist* seconded from Rubber Technical Developments Limited, from 21 February to 16 December.

K. C. Sekar, B.A., A.I.R.I. *Assistant Chemist.* (First appointed 1 October 1928)

R. C. H. Hsia, B.Sc. *Assistant Chemist.* (First appointed 2 January 1953)

Cheah Sein Liat, B.Sc. *Assistant Chemist.* Resigned with effect from 3 August. (First appointed 3 August 1948)

B. C. Sekhar, B.Sc. *Assistant Chemist.* On study course in U.S.A. and England until 23 November. (First appointed 15 September 1949)

S. J. Tata, B.Sc. *Assistant Chemist.* (First appointed 14 December 1953)

SMALLHOLDERS' ADVISORY SERVICE

L. R. Davidson, B.Sc. (Agr). *Smallholders' Advisory Officer.* On leave from 24 August. (First appointed 1 December 1940)

J. M. F. Greenwood, B.Sc.(Agr). *Assistant Smallholders' Advisory Officer.* (First appointed 25 November 1948)

J. W. L. Bevan, B.Sc.(Agr). *Assistant Smallholders' Advisory Officer.* Seconded to Joint Working Party until 31 May. First appointed 12 November 1952)

LIABILITIES

	$ c	$ c	$ c
SUNDRY CREDITORS			
Staff		33,759.92	
Merchants		105,256.58	
Building Contractors		70,597.33	
Miscellaneous		14,166.57	223,780.40
STAFF CONTINGENCY RESERVE			
As at 31 December 1954			330,000.00
RESERVE FUND FOR GRATUITIES FOR EQUALISATION OF PROVIDENT FUND CONTRIBUTIONS			16,792.00
EXCESS OF ASSETS OVER LIABILITIES			
As at 31 December 1953		1,203,522.09	
Add Grants from Malayan Rubber Fund for Capital Works under 5 Year Plan 1949/53		2,594,912.93	
War Damage Dividends received	76,862.00		
Less Transfer to Malayan Rubber Fund	75,026.00	1,836.00	
		3,800,271.02	
Add Excess of Income over Expenditure for year			
Rubber Research Institute	227,039.33		
Experiment Station	182,325.62	409,364.95	4,209,635.97

Note Refunds of the Rubber Industry (Replanting) Board Cesses have been included in these accounts to the following extent:

Schedule IV Refunds for the period 1 January to 30 September, 1954.

Carried forward	4,780,208.37

ASSETS

		$ c	$ c	$ c
LAND & BUILDINGS				
2¼ Mile Compound				
Land as at 31 December 1953		15,784.35		
198 & 200 Ampang Road:				
At Nominal Value		2.00	15,786.35	
3rd Mile Compound				
Land as at 31 December 1953		31,440.35		
251, 253, 255, 257, 259 & 261 Ampang Road:				
At Nominal Value		6.00	31,446.35	
3¼ Mile Compound				
Land as at 31 December 1953		27,582.50		
262, 264, 266, 268 & 270 Ampang Road:				
At Nominal Value		5.00	27,587.50	
4th Mile Compound				
Land as at 31 December 1953		2,000.00		
73, 4th Mile, Ampang Road:				
At Nominal Value		1.00	2,001.00	
Eaton Road Compound				
Land as at 31 December 1953		17,147.08		
1, 3, 5 & 7 Eaton Road:				
At Nominal Value		4.00	17,151.08	
Wickham Road & Ridley Close				
Land as at 31 December 1953		43,623.50		
Nine Bungalows				
As at 31 December 1953		461,540.65	505,164.15	
Ulu Klang				
Land as at 31 December 1953		7,705.00		
Workmen's Quarters:				
As at 31 December 1953		1.00	7,706.00	
Ampang Road Laboratories				
Land as at 31 December 1953	19,526.00			
Buildings at nominal value	1.00	19,527.00		
Additions as at 31 December 1953		106,228.98		
Additions during the year		43,899.51	169,655.49	
Sungei Buloh Laboratories & Houses				
As at 31 December 1953		799,893.76		
Additions during the year		10,489.19	810,382.95	
Quarters for Rubber Instructors				
As at 31 December 1953		4,270.00		
Additions during the year		427.76	4,697.76	1,591,578.63
PLANT & MACHINERY				
As at 31 December 1953				
At Nominal Value				1.00
RUBBER POWDER PLANT & MACHINERY				
As at 31 December 1953				24,770.03
FURNITURE				
Residential Houses, Kuala Lumpur				
As at 31 December 1953				
At Nominal Value			1.00	
	Carried forward		1.00	1,616,349.66

Brought forward	$4,780,208.37
Carried forward	$4,780,208.37

		$ c	$ c
FURNITURE (contd)	**Brought forward**	1.00	1,616,349.66
Sungei Buloh			
As at 31 December 1953			
At Nominal Value		1.00	
Offices, Kuala Lumpur			
As at 31 December 1953			
At Nominal Value		1.00	
Library			
As at 31 December 1953			
At Nominal Value		1.00	
Laboratories			
As at 31 December 1953			
At Nominal Value:			
Kuala Lumpur		1.00	
Sungei Buloh		1.00	6.00
APPARATUS & GLASSWARE			
As at 31 December 1953			
At Nominal Value			1.00
MOTOR VEHICLES			
As at 31 December 1953			
At Nominal Value			1.00
WORKSHOPS			
As at 31 December 1953			
At Nominal Value			1.00
LIBRARY BOOKS & PERIODICALS			
As at 31 December 1953			
At Nominal Value			1.00
EXPERIMENT STATION DEVELOPMENT			
As at 31 December 1953		1,576,243.62	
Additions during the year		193,569.74	1,769,813.36
			3,386,173.02
STOCKS			
Petrol, Oil & Chemicals			
Head Office	371.30		
Experiment Station	1,380.08	1,751.38	
Empty Drums & Containers			
Head Office	383.00		
Experiment Station	2,580.00	2,963.00	
Stationery			
Head Office		6,227.67	
Sundry Materials			
Head Office	6,325.80		
Experiment Station	24,147.70	30,473.50	
Rubber			
Experiment Station		13,246.72	54,662.27
SUNDRY DEPOSITS			170.00
SUNDRY DEBTORS			
Staff			
Loans for Motor Vehicle Purchase	163,526.68		
Travelling & Leave Advances	18,814.75	182,341.43	
	Carried forward	182,341.43	3,441,005.29

	$
Brought forward	4,780,2
	$4,780,2

REPORT OF THE AUDITORS TO THE BOARD OF THE RUBBER RESEARCH INSTITUTE OF MALAYA

We have examined the above Balance Sheet with the books and vouchers of explanations we have required.

In our opinion this Balance Sheet is properly drawn up so as to exhibit a true best of our information and the explanations given to us and as shown by the books of

Kuala Lumpur
9 March 1955

		$ c	$ c
Brought forward		182,341.43	3,441,005.29
SUNDRY DEBTORS (contd)			
General			
Head Office	98,566.23		
Experiment Station	5,978.67	104,544.90	
Interest Accrued on Investments		2,729.97	
Payments in Advance			
Head Office	13,236.91		
Experiment Station	15,193.92	28,430.83	318,047.13
INVESTMENTS			
$15,000/– 4½% Singapore Municipal Debenture Stock 1930-70/80: As at 31 December 1953 ($17,537/-*) ($15,412/-†)		15,000.00	
$40,000/– 3% F.M.S. Govt. War Loan 1940-52/59 As at 31 December 1953 ($40,000/-*) ($40,000/-†)		40,000.00	
$160.000/– 3% Malayan Union Govt. Loan 1946-62/66 As at 31 December 1953 ($160,000/-*) ($142,400/-†)		160,000.00	215,000.00
($217,537/-*) ($197,812/-†)			
* Original Cost † Market Value as at 31 December 1954			
POST OFFICE SAVINGS BANK			
Deposit for Retirement Gratuities			16,792.00
CASH AT BANK AND IN HAND			
Chartered Bank, London		2,058.43	
Chartered Bank, Kuala Lumpur		782,108.25	
In Hand		5,197.27	789,363.95
			$4,780,208.37

er Research Institute of Malaya and report that we have obtained all the information and

ct view of the state of the Institute's affairs as at 31 December 1954 according to the ute.

Sgd Peat, Marwick, Mitchell & Co.
Chartered Accountants
Auditors

To EXPENDITURE

	$ c
Board & Committee (fee & expenses)	2,045.10
London Advisory Committee:	
Contribution for Research	86,002.24
International Rubber Research Board	
Contribution for Research	11,676.23
Salaries & Allowances	1,319,483.45
Gratuities (including transfer to Reserve for Gratuities)	23,283.00
Provident Fund Contributions	125,446.77
Leave Pay & Passages	118,781.98
Medical	17,829.81
Recruiting	4,855.61
Travelling	62,829.29
Printing, Stationery, Postage, Telephone, Audit and Legal	34,887.20
Rents, Rates & Taxes	13,056.90
Insurance	25,902.54
Maintenance of Laboratories & Houses	108,553.67
Maintenance of Grounds	5,966.38
Furniture & Office Equipment	17,464.24
Fixtures & Fittings	7,204.75
Power, Light, Water & Sanitation	59,861.94
Plant & Machinery — Repairs & Running (excluding power)	13,378.57
Workshop	5,766.60
Apparatus & Glassware	75,729.25
Motor Vehicle Running Expenses	12,152.04
Chemicals	17,948.83
Publications	13,612.70
Library—New Books, Periodicals & Sundries	11,205.71
Exhibitions & Conferences	1,451.24
Smallholders' Advisory Service	495,443.01
Experiments:	
Field & Testing Laboratories	62,957.16
Technical Classification of Rubber	30,031.20
	2,784,807.41
Excess of Income over Expenditure for the year	227,039.33
	3,011,846.74

Income & Expenditure Account for Exper

To EXPENDITURE

	$ c
Revenue Expenditure	541,910.18
Excess of Income over Expenditure	182,325.62
	724,235.80

on) for the year ended 31 December 1954

INCOME

By	$ c	$ c
Contributions received from the Malayan Rubber Fund		2,940,630.00
Publications sold	7,098.16	
Rents on Houses	23,327.42	
Interest on Loans	2,991.26	
Interest on Investments	6,674.16	
Miscellaneous	31,125.74	71,216.74
		3,011,846.74

on year ended 31 December 1954

INCOME

By	$ c
Sales & Stock of Rubber	665,621.78
Sales of Planting Materials	24,759.44
Rubber Industry (Replanting) Board Refund on account of Replanting Cess	33,854.58
	724,235.80

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